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THE FUTURE "WORLD'S HIGHWAY."

I. GENERAL ASPECTS.

By T. Graham Gribble, C. E.

THE mellifluous Greek word "Irene" has for its origin three words signifying "connecting into one." Our synonym "peace," while lacking the full measure of such expressiveness, carries an equal force of meaning. It is not a mere cessation of hostility, but rest, union and friendliness, which are all included within its compass. The noblest laurels which rest upon the achievements of modern civil engineers are those which belong to the peace-maker. The families of the earth are rapidly being connected by mutual ties of commerce and social intercourse. Barriers of race, custom and superstition are disappearing. Continents are brought within range of federal government more effectually than petty principalities a century ago. The most distant and diverse nations are on speaking terms. War is draped under deeper and deeper stigma of barbarism.

The Anglo-Saxon race, having passed through its nonage with all the shortsighted blunders of childhood and their inevitable retribution, stands to-day nearest of all the peoples to the full intelligence of manhood. It has already sighted its ideal and strains after the complete fruition of a union, elastic and yet unbreakable, invulnerable in its peaceful strength, having its foundations in the principles of justice, liberty and toleration, and its structure welded by those kindly sentiments and social ties which, notwithstanding all minor differences, lurk in the mother tongue.

It is to improved means of communication more than to

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sentiment that we owe the present trend of public feeling towards union or affiliation. As the world in general and consanguineous races in particular are brought ever in closer touch by swift steamships, lightning express trains and the subtler electric fluid, it becomes more difficult for the unscrupulous agitator or the interested partisan to stir them into strife.

America, which Froude so aptly terms the fusing-pot of the nations, is the proprietor of 170,000 miles of railroads, and that is her flux. She has, however, another and more natural highway which awaits a little more delving by the engineer into the shoals and gaps which obstruct it, and from the far North to the Mexican Gulf and from the great Northwest to the Atlantic Ocean she will have a waterway on which to carry her people and her produce throughout her borders and thence to the furthest foreign shores. If one flag had been floating over the United States and Canada there is good reason for believing that this great work would have been accomplished already. But instead of a common highway there is a scientific frontier barred by fiscal restrictions and guarded by treaties with jealous care. Great Britain holds on to Canada as an essential factor in her schemes of colonial federation. The United States desire a union with her, but do not wish to quarrel about it. Canada herself halts between two opinions. The general public feeling is that some change is inevitable, but as yet no scheme has formed into definite shape above the horizon. It is not the politicians but the people who must bridge the gap and weld the disunited members.

When on both sides of the lakes and the Saint Lawrence the people who speak the same tongue have made up their minds; when they have settled upon the main points in which the progress of development is now hindered, they will give the politicians no longer a subject for discussion but a task to accomplish.

Great Britain has to-day vastly greater business interests in the United States than she has in Canada. It is not unreasonable to anticipate that by a closer alliance between the greater nations, rather than by a quarrel, the fusing of the Dominion with the Republic should take place.

America needs a through route from Duluth to Liverpool and Manchester to bring her into still closer touch with the Old World, and she needs a through route from New York to New Orleans to girdle her own eastern dominions and form a vital artery through the heart of her vast continent. Without contemplating the even-

tuality of another civil war, in which the latter waterway would be needed for the transport of war vessels, America needs this channel for the futherance of commerce between the States, "connecting them into one" by stronger and stronger bonds of mutual advantage until the very idea of civil war shall be nothing but the memory of a by-gone horror.

The problem of development by improved waterways from the great lakes southward and eastward must be considered as a whole. Fairness to the question demands that the difficulties which attach to a project of such vast magnitude should be given all the weight which belongs to them. Already immense sums of public and private capital have been spent upon the preliminary task of understanding the situation. It is probable that a great deal more money will have to be spent in collecting the views and schemes of every form of interest concerned, before the matter is brought to a head. It would seem as if an international commission would ultimately require to be established in order to systematize it into an organic whole so that, whether carried out simultaneously or in sections according to the more urgent requirements of the hour, when finished it would stand as a work of cosmopolitan benefit.

One of the difficulties which meets the ordinary mind at the outset is that the engineer is called upon in solving the question to interfere with nature's waterworks on a scale which dwarfs all his previous manipulations into insignificance. At present the vast gathering ground of the southern portions of British America and the northern and northwestern States of the Union empties its waters over Niagara, forming by its channel the boundary line between two friendly nations, but who are each of them quite alive to their respective water-rights. In ancient times, Lakes Superior, Huron and Michigan are believed to have drained into the Mississippi through the Chicago divide and down the Illinois River. At that time the Winnipeg basin which now drains into Hudson's Bay is also supposed to have fed the Mississippi.

The advocates of a southern outlet for Lake Michigan argue that there would thus be a restoration of nature's first ideas. It is true that the same hand that first made the southern outlet afterwards closed it, and it was not the hand of the hydraulic engineer. But since so learned a consensus of expert opinions decides that nature's first thoughts were her best, we must conclude that she made a mistake the second time and backslid down Niagara.

Naturally the first question occurring at the suggested outlet

through Chicago was that of how the level of the lakes and the discharge through the Detroit River would be affected. A "Citizens Association" was formed in Chicago to promote the cause of the deep waterway and to gather together all existing information, and some of the most eminent hydraulic engineers made careful and voluminous reports. The data were furnished from surveys and observations extending over many years; and a unanimous verdict given that the effect would be inappreciable from the abstraction of the quantity of water which would be required for the purpose and that no one would be aware of the alteration at either Detroit, Buffalo or Niagara. In fact the notion of detriment to any one was as lightly esteemed as that of the innocent peasant who in the Black Forest dammed up the rivulet which forms the source of the Danube and then said: "Now, how will you fellows down at Vienna get along?"

Without proposing to question the soundness of the deduction it is clear that there is considerable difference of opinion between American civil and military engineers upon what is the most feasible method of obtaining a navigable waterway from Chicago to New Orleans. It is furthermore strongly held by residents on the St. Clair and Detroit rivers that the effect of the Government improvements in deepening the channel in Lake St. Clair has been to lower the level of the lakes, although in this case it is not an actual abstraction of water but an improved waterway which is the cause. In addition to this the question arises as to where, if they begin to draw upon Lake Michigan, the limit of the borrowing powers will be reached. The present demand is the very modest quantity of about one-fortieth part of the flow over Niagara, and as that waterfall is now nearly all running to waste there would not seem to be any ground for grumbling. But one of the leading experts gives expression to the view, although he qualifies it with the remark that to advocate it at present would be injudicious, that it would be entirely practicable to obtain a waterway thirty feet deep from Chicago to the Mississippi by means of water from Lake Michigan. At present they only ask for a depth of fourteen feet. But how long will that suffice? Almost as soon as the Suez Canal was finished they began to talk about a second one. If this waterway should realize the expectations of the promoters, and there is every reason for believing that it would, a new and immense industry would be built up all along its banks, clamoring every year for more and more room. People owning mills along the route are already trying to discount the advantages which will accrue to them by bonding their

THE GREAT LAKES TO THE GULF AND TO THE ATLANTIC.

property at its future value. On the other hand the Niagara people are busily engaged upon great water schemes, and propositions are afloat for using a very large proportion of what now runs to waste. It is easy to see that complications either international or domestic might arise in the near future if ancient proprietors could show that they had received detriment from the new-comers' operations. Another feature of the problem is the Mississippi itself. When a fourteen-foot waterway is proposed from Chicago to St. Louis with a twenty-foot depth close at its heels and a possible thirty-foot as the final demand, it is not merely a question of 300 miles of Illinois-river improvement but of thirteen hundred miles of the great Mississippi, to be dredged or trained between levees or otherwise improved in order to obtain an equal depth right through the waterway. It is clearly a herculean task to grapple with and it is only a united America who could sit down to put it into practical shape.

Another and peculiar factor in the problem is that Chicago, which is perhaps the most potent moving force in the present agitation, needs an outlet for her sewage. She proposes to help towards the waterway if she can put her sewage into it. At present it makes the Chicago River into a cesspool and the experts claim that it can be so diluted by water from the lake that when forming part of the new waterway it would be perfectly inoffensive to human beings and quite an acquisition to the fish. On the other hand the local United States engineer, Captain Marshall, here espies "a nigger on the fence," and in his report to the Government considers that an attempt is made by the great city to obtain national funds for her private necessities. The sharp conflict between civil and military experts on this point serves not only to show the complexity of the problem but to bring to light the immense quantity of valuable research which has been devoted to its solution.

With regard to the general aspects of the eastward waterway, amidst a host of schemes there stand out into prominence two main routes which may be called the American and Canadian and two methods of construction, by carrying the vessels water-borne or transporting them over ship-railways across the gaps. The American route includes a development of the Erie Canal and ends in New York Harbor; the Canadian route includes a Niagara ship-canal and a Huron-Ontario ship-canal or ship-railway and ends at the Straits of Belle Isle.

In attempting to cope with this problem, there is another difficulty which is in marked contrast with rail development.

When once a standard gage is adopted, with standard cars and uniformity everywhere along the line, railway-making has the advantage of simplicity and finality. A little branch railway switched on to some main line is in touch with the whole American continent. A through waterway on the other hand has to deal with all kinds of rivers from the mountain torrent dashing over its rocky bed to the sluggish and meandering stream with bars and shoals. It has to tackle old-fashioned canals, to widen and deepen locks, to remove dams, and worst of all it labors under an uneasy sensation of possible lack of finality. In most cases canal-making has fallen behind the march of progress because the shipping has outgrown it. It was a comparatively easy matter to develop the first "one-horse" railways into our present magnificent trunk-lines. The infant had sufficient elasticity in its composition to expand with the times. But the canals of our forefathers came into the world, as physiologists would put it, a fixed species incapable of further evolution. Cities have grown up along their banks so that they cannot be widened. Locks of masonry require to be removed entirely in order to get greater depth and the navigation must stop while it is being done. Thus, until the recent movement for deep waterways brought them into the prominent consideration of engineers, they had come to be regarded as moribund. In some cases they have been handed over to railway companies as a concession for the advantage to the community of a better means of transit.

The question of what kind of vessels would have to be provided for in the proposed waterway is therefore a most difficult one to answer.

It may be that the "whaleback" barge and steamer is a solution of the problem. If, in that way, economical transport with moderate draft can be obtained, it would give the matter some finality. If, on the other hand, it may be expected that the ocean-going steamers will continue to increase in depth, the point of finality must be the limit of outlay which it is advisable and practicable to make upon so national an enterprise. It will be shown later on what a vast difference of cost one extra foot of depth may make upon the whole undertaking. On the other hand, the ship railway possesses some great advantages over the canal. It is cheaper by far than cutting down to water level in a hilly country. It can handle all classes ofvessels. It does not involve detention at locks. Although less in first cost, it is more expensive to operate and maintain unless the canal requires much dredging. But as yet the ship-

railway awaits the test of experience. The result may be to determine to what extent and under what conditions the ship-railway is preferable to the canal and vice versa, but it will not affect the desirability of the project as a whole.

To sum up the matter, the American continent, supplied already with innumerable veins, now seeks two main arteries for the transport of its produce. There is in no sense here a rival for the railway. Passenger travel and rapid transport of certain kinds of merchandise always will prefer the railroad. In addition to this, railways will increase and multiply for the distribution of produce throughout the whole expanse of the land. But when we review the development of America during recent years into the granary of the world, when we look forward to her as its vineyard and its orchard, when we take a glance at the continuous procession of its grain and mineral-carrying steamers through the Detroit River, it is easy to see that there is even now a demand and there will be, before people have done discussing it, an urgent necessity, for two great arterial water connections along which freight can be handled clear athwart this continent at a minimum cost of transportation.

If it be attempted to let this problem solve itself by degrees, as the numerous isolated schemes involved in it arrive at paramount importance, the probability is that it will become involved in a mass of conflicting interests, but if it were undertaken internationally and as a whole, it is possible that it might become a stepping stone to a race-combination greater than has yet appeared on the surface of the earth.

In the next article the subject of the Southern outlet from Lake Michigan and the great North and South waterway will be considered, leaving for the third and last paper the subject of the Eastern waterway.

DO WATERWAYS BENEFIT RAILWAYS?

By Lewis M. Haupt, M. Am. Soc. C. E.

AT this stage of the development of transportation systems the very idea suggested by this query appears to a large class of traffic-managers to be an absurdity unworthy of consideration. The railroad mileage is so great (171,000 miles), the rates so low, and the service so greatly improved as to appear to leave nothing to be desired. But the railroads constitute only one element in a mutually dependent system of which the extremes are the highways and the waterway. The functions of a line of communication are to convey the raw product to the consumer over the line of least resistance, which should be also that of least cost. Tracing the course of any food product after it has been garnered, we find its path is first over a country road to a station, thence by rail to a terminal, thence over city streets to an agent or warehouse, thence to the consumer over similar resistances, and after its life-giving elements are absorbed its disintegrated remains are conveyed either through a system of sewers by water carriage, or by dry removal to a place of disposal. The mineral product undergoes a like experience in its transformations from the mine to the manufactured article. For articles intended for home consumption or use the path traversed may be limited to the two overland systems, but for those designed for the foreign markets all three modes of conveyance must be employed.

The total cost of the movement must consist therefore of at least two and often of the three factors included in the cost of wagon, rail and water carriage, to say nothing of terminal charges, commissions, tolls, insurance and other items. The margin between the cost of production or manufacture and the selling-price determines the *market-range*, or the distance which the article may be carried, and it has been the policy of all traffic managers so far as practicable to adjust their rates so as to obtain for their companies all the profit this margin would afford without entirely destroying their traffic. Thus for short distances the tariffs were made much higher than long ones, independent of the higher ratio of terminal charges and possibly smaller amount of business. This virtually eliminated the advantage resulting from proximity to

markets and imposed a hardship upon suburban holders in consequence of increased taxes and interest on invested property.

This policy of charging "what the traffic would bear" has not only resulted in restricting the business of the railroads, but has greatly retarded the growth of the country by placing an embargo upon commerce which has increased the cost of all articles requiring transportation. The recent improvements in rolling-stock and way on our trunk-lines, whereby the ratio of dead to paying load has been reduced from 1 to 1, to 1 to 3, resulting in a large reduction of rates, has had the effect of stimulating all classes of industries, cheapening products and of giving to the roads a larger volume of business throughout the year with greater net returns.

This effect is well illustrated in the case of the Pennsylvania Railroad as stated in Ringwalt's Transportation Systems of the United States, page 130:

"General Herman Haupt,* in his testimony before the Senate Committee on Transportation Routes to the Seaboard, October 22, 1873, said that it was a subject of animated discussion twenty-five years ago (1848) in the Pennsylvania Railroad Board whether a low rate should be established to admit of the transportation of coal, and the position taken was that coal and such articles could not be transported on railroads; that the canals, such as we then had in Pennsylvania, would answer very well for the transportation of such articles, but railroads must be used exclusively for passengers and light freights; that anything carried at a less cost than two cents a ton-mile would be a positive loss; *the cost then exceeded two cents a ton mile*, and at that time there was a tonnage of only a hundred thousand tons over the Pennsylvania Railroad. In order to demonstrate the practicability of carrying coal I made an analysis of the business of the preceding year, separating those items which would be increased by an increased business from the general and constant expenses, which were independent of the volume of tonnage. After making a careful analysis, I succeeded in demonstrating that the actual cost of the transportation of coal would not exceed about seven or eight mills per ton-mile, while it would bear a price for freight of a cent and a quarter. Subsequently the Pennsylvania Railroad Company engaged in coal transportation and now (1873) their whole average charge for transportation of all classes of freight is only one cent and four mills for all the business of the road which exceeded 8,000,000 tons per annum. The actual cost of service with a smaller volume of tonnage then exceeded *two cents* a ton mile as previously stated."

The effect of this policy, introduced at that early date at the instance of its Chief Engineer and Superintendent, has been to make this road one of the most extensive and influential in the world, and the result of its continuation has been to increase the business to the enormous aggregate of over seventy millions of tons moved in 1890 on the line east of Pittsburgh, and to reduce the rates still

* Former Chief Engineer and General Superintendent Pennsylvania Railroad.

further until many bulky articles are carried at a profit for less than a half cent per ton mile. This reduction in rate has had the effect of largely increasing the business of the railroads and at the same time greatly augmenting their profits, and it was brought about to a great extent by the competition and lower rates of the canals which the railroad companies could not meet without loss. Hence the war of extermination was waged against canals and the use of every form of stratagem to wreck them or buy them up.

The testimony relative to the policy of the Pennsylvania Railroad above referred to was made from memory, but the original correspondence between the Chief Engineer and the President of the road which led to the adoption of the low rate and large volume has just been discovered among some old letters and possesses such important historic interest that a few extracts are deemed worthy of insertion in this place:

PHILADELPHIA, Nov. 17, 1853.

J. Edgar Thomson, Esq., President Pennsylvania Railroad:

DEAR SIR: * * * I consider that the great objects of the construction of the Pennsylvania Railroad were to build up the city of Philadelphia, to promote the increase of trade and the general prosperity of the State, and at the same time to pay fair dividends to the stockholders.

I consider from 8 to 10 per cent. a fair dividend and this may be earned either by a small business at high rates or by a large business at low rates. If the Pennsylvania Railroad Company should refuse to carry a single pound of ordinary freight and confine their business to passengers and express, I believe that dividends of 8 per cent. could be paid, but such a policy would be injurious in the extreme to the commercial interests of Philadelphia, which require that every possible facility should be afforded to trade and every effort made to bring upon the road the largest business that it can accommodate. To secure these advantages a system of low charges upon articles of great weight and little relative value is indispensable. In a word the motto of the company should be *a large business, low rates and fair dividends.* But until the road is double-tracked the low rates must be limited to articles carried for "back loading" or at the convenience of the company.

When a road is in a condition to accommodate an increased tonnage, the cost of doing the increased business and the profits resulting from it must not be estimated by charging this business with an average of the expenses but only with the increase consequent upon its carriage. * * * [Here follows illustration by examples and statistics.] * * * From these results I am led to conclude that if the Pennsylvania Railroad Company had a double-track road under one management they could transport coal at a cost of about one half cent per ton per mile without actual loss, and lumber at 9 mills per 1000 feet, and that a charge of one cent per ton per mile on an increased business of 500,000 tons carried 200 miles would pay a net profit of 5 per cent. on $10,000,000, furnishing a most desirable increase to the revenue of the road, if we were in a position to accommodate it, which of course we never shall be while that incubus, the State tax, continues.

But even if this business did not pay a dollar of revenue my opinion is that it would be to the interest of all parties that it should be accommodated as it would give employment to a large population and stimulate many other important interests. * * * It should be observed that even if low rates should be permanently fixed upon coal and lumber it would be a year or more before the stimulus of this reduction could lead to a sufficient increase to embarrass our transportation, by which time we could be prepared for it. * * * Under the influence of such opinions I have encouraged those who have consulted me to invest capital in coal and lumber operations and make extensive improvements. So clear to me did the true policy and interests of the company appear that I could not suppose it possible that a different view would be taken by those who would have the management of the traffic. The existing policy is calculated to reduce the business within very narrow limits. * * *

This letter has been written, not as an officer of the company, but as an individual. I have, as you know, no connection in any way with transportation or regulation of tolls, and therefore could see no impropriety in defining my position and in giving an expression of opinion.

Yours truly, H. HAUPT.

At the time this was written the business of the company probably did not exceed a quarter of a million tons per annum, and the mere suggestion of a possible tonnage reaching to one million was regarded as visionary. Moreover the proposition to repeal the tonnage tax of three mills per ton per mile, which could readily have been effected during the first two years of operation, was ignored, and it was soon realized by the State that these taxes would be sufficient to pay the whole of the State debt of $40,000,000, and to remove this burden the railroad company was subsequently obliged to buy up these public works, most of which have been allowed to fall into disuse. The only person who publicly acknowledged the soundness of this policy of low rates at that time was Mr. Thomas A. Scott, appointed by H. Haupt, and who succeeded Mr. Thomson to the presidency and aided in establishing the supremacy of this company.

But although it was supposed that the minimum limit for freight charges had been touched some years ago the price continues to recede, and the bottom has not yet been reached. The waterways which are beyond the control of the railroads are the vitalizing elements in this problem, and paradoxical as it may seem the railroads which have the largest business, pay the largest dividends and whose securities are at a premium, are those which parallel these cheap waterways. By increased draught on the great lakes and improved vessels the rate from Chicago to Buffalo has been reduced to $\frac{1}{2}$ cent per bushel or 15 mills per ton-mile, which is only $\frac{1}{3}$ that of the lowest rate by the Lake Shore road. On the Mississippi

and Ohio it is only $\frac{3}{8}$ of a *mill* per ton-mile. On the ocean it is still lower.

In strong contrast with these figures we may take a retrospect of forty-four years ago, when a rail and waterway were in competition. In 1848 the statement of the Camden & Amboy Railroad Company showed that it had transported during the year only 1983 tons carried 90 miles=178,470 ton-miles, for which $21,115 were received, giving the rate of 11.9 cents per ton-mile, while the Delaware and Raritan Canal for the same year showed 9,293,680 ton-miles carried for $100,984 giving a rate of 1.08 cents per ton-mile * which is only one-eleventh that of the railroad. Certainly there has been no revolution in natural laws which would account for the great reduction in relative rates and the prevalent opinion among certain interested classes that canals are obsolete and their day of usefulness has passed. To their influence, primarily, must be attributed the existing low tariffs and consequent magnificent development of the railroad system and of our material resources. Had the same intelligent and fostering care been bestowed upon the canal system as has been devoted to the railroad it would be much farther in the ascendant than it is to-day. Even as it is, those canals which have survived the siege and are managed by private owners are abundantly able to transport their freights at a rate of about one-third the present low rail tariffs and make money.

But the same principle of increased ratio of live to dead load when applied to canals will still further lower their rate and this result may readily be obtained by increasing their depth and the consequent capacity of their vessels and by improved modes of transport. Hence the general awakening to the importance of the class known as ship-canals, having a draught of from 15 to 26 feet. This will be done, too, without injury to the railway system, as will appear upon reflection. The business of a railway is largely dependent upon population and it is the local traffic which pays the best. Cheap freights stimulate manufactures and every artisan requires a number of purveyors to maintain his existence. It would be interesting to determine just how many of each kind would constitute a well-balanced community, but that is not germane to the subject. There should be available at least a butcher, grocer, baker, milkman, tailor, shoemaker, merchant, and many others who live upon the necessities of their fellow-men. There is another

* Ringwalt, page 131.

class who exist upon emergencies, as doctors, dentists, and a third who may be called upon to cultivate the moral, intellectual and spiritual faculties. In short, every artisan settled upon the line of a railroad requires at least one other person to inhabit the same place to provide for his necessities. Supplies must be brought to him generally from a distance. The best class of settlers for a railroad, therefore, are manufacturers or miners, as they not only require materials but food and merchandise, producing freight in both directions and inducing also a rapid increase of population.

Manufacturing centers are stimulated by and generally located upon waterways or where power and supplies may be obtained with certainty and at low rates. Thus it is found that the valleys of the Mohawk, Hudson, Schuylkill, Lehigh and many others, where the populations are most dense, were soon skirted by the railroads desirous of securing the business created by these facilities.

In a general sense, therefore, it is seen that the existence of a waterway has proven beneficial to the railways but if the question be examined specifically it will also be found that those railways which parallel navigable channels are doing a larger business and at a greater profit than those which merely connect water terminals. The most remarkable instance of this kind is to be found in the State of New York, where the New York Central & Hudson River and West Shore Railroads, paralleling the Erie Canal and Hudson River, are brought into competition not only with the waterway but also with the "Erie" Railway between the same terminals, which is nineteen miles shorter.

In 1890 the former earned 5.21 per cent. profits on its total obligations, and declared a 4½ per cent. dividend while the latter declared no dividend and its stock is quoted at $22, while that of the Central is held at at $117 per share. Again the New York, New Haven & Hartford, which skirts the Sound, pays 10 per cent. dividends. The Lake Shore, which is crowded close to the shores of Lake Erie, earned 10 per cent. of its capital and declared a 6 per cent. dividend. Its stock is held at $123. So with the Rome, Watertown & Ogdensburg, bordering Lake Ontario, which is quoted at $112.

Many similar instances might be cited, especially in foreign countries, where waterways are recognized as important avenues of commerce, but it is unnecessary, for the spirit of the press and the public agitation in favor of deep-draught waterways connecting the Great Lakes with tide-water and with the Mississippi and Ohio

rivers; the Ship-Canal Across New Jersey and its extension to open up the land-locked system of the Atlantic and Gulf Coast; the international project via Lake Nicaragua, of paramount importance, and others of lesser note all point to an awakening in behalf of cheap rates and shorter distances for moving the commerce of this country, which has come none too soon. Its benefits will not be limited to any class of citizens or corporations but will affect all countries peoples and interests, not excluding the railroads.

I am fully convinced, therefore, that a broader and more liberal policy of railroad managers and operators towards parallel waterways, especially where those channels are owned by the railroads, would lead to far-reaching benefits to themselves, their patrons, and all others dependent upon transportation.

The same policy extended towards our road system as a feeder to the railroad would result in a great reduction of resistances and consequent cost of moving freights to the various way stations of the country. The railroads can as readily afford to take an interest in the development of an improved condition of our highway systems as can any other corporations or interests and they will be the first to be benefitted by an enormous increase in suburban traffic as well as a more uniform distribution and supply of freight.

How greatly the cost may be reduced by merely improving the hardness and smoothness of the surface will become apparent by an inspection of the accompanying table showing power and cost of moving a ton-mile over various level surfaces:

	Pounds.	Cost per ton-mile.
Wet clay or mud	1000	$1.00
Sand (dry)	400	.40
Hard earth road	200	.20
Macadam road	100	.10
Wood or plank road	50	.05
Brick pavement	25	.025
Asphalt	15	.015
Railroad	9	.009
Canal	1.5	.0015

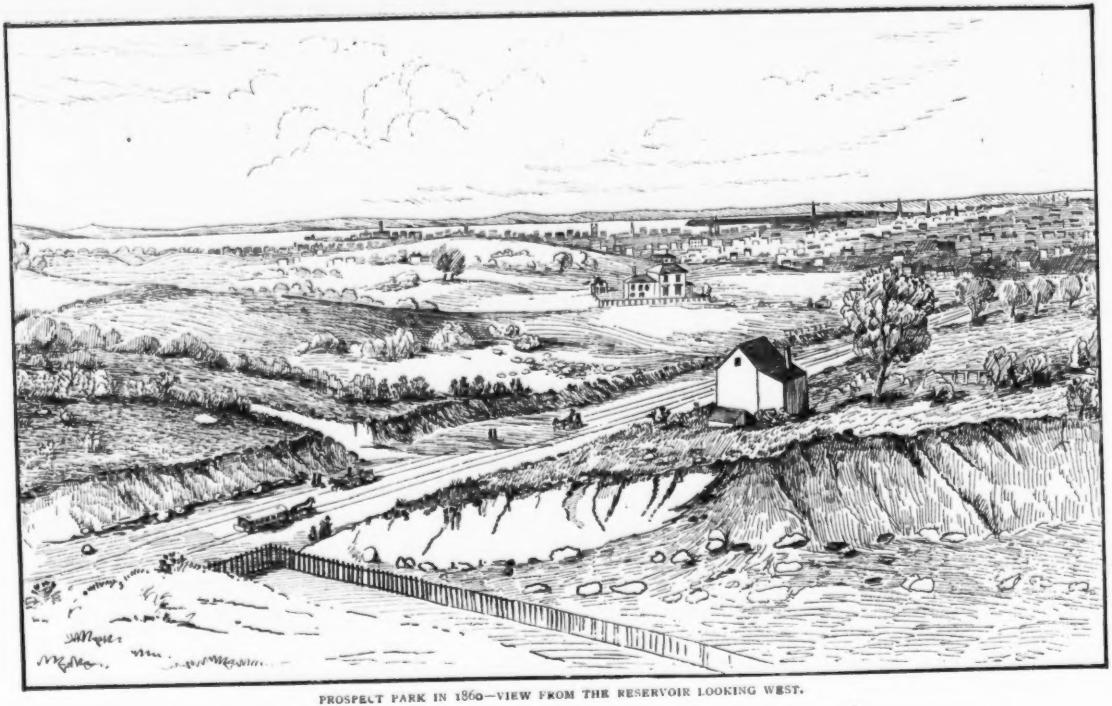
The records for lakes, rivers and ocean are so microscopic as to be almost incredible. The whalebacks show only a consumption of a fraction of an *ounce* of fuel per ton-mile. The cost of movement may be stated at one-tenth the traction force in pounds, but on canals it is believed that with cable or electric traction and by increasing the draught and capacity, the cost can be very greatly reduced.

BEAUTIFUL PROSPECT PARK, BROOKLYN.

By John De Wolf.

ONLY those whose training in landscape work or experience in park management enables them to judge, can justly appreciate the work, and the skill that directed it, in creating Prospect Park in the city of Brooklyn, but the lovely and satisfactory result is perhaps valued as highly by those having access to it as park work has been anywhere in the world. Visitors to New York, too often occupied with other attractions, neglect to visit this most charming of metropolitan surroundings, although easy of access without great expenditure of time. It is thought by many critics of landscape art that within the bounds of Prospect Park are to be found the most perfect examples of apparent naturalness, created by artificial means, existing in America or, perhaps, in any other country. The casual visitor admires the pastoral and sylvan beauty all about him and the skill with which the walks and roads are made to wind through it, little thinking that the whole was created by the hands of men. What higher compliment could be paid to art? If he knows trees then of course he can tell that many of them are from foreign sources. Otherwise they seem to grow from the soil by nature's agency alone. These bosky thickets, screening the walks and drives from each other, seemingly so far from the haunts of man, were all planted there, and the umbrageous boughs that spread above the gently-rolling greensward, with grace so natural, are trimmed and trained with studied but unseen art.

Sooner or later many of our rapidly-growing cities will be compelled to provide ample open spaces for public resort, not only for pleasure and comfort but as essential to the physical health and the mental and moral growth of the people. The questions involved are becoming more urgent from the rapid increase of our urban population, in proportion with that of the whole country. With more than half of our people inhabiting towns, and in some sections actually fewer persons on the farms than in the past, it becomes more necessary to give the towns some of the advantages of country life, if we are to prevent our sure degeneration as a people. The tendency of population towards the towns is likely

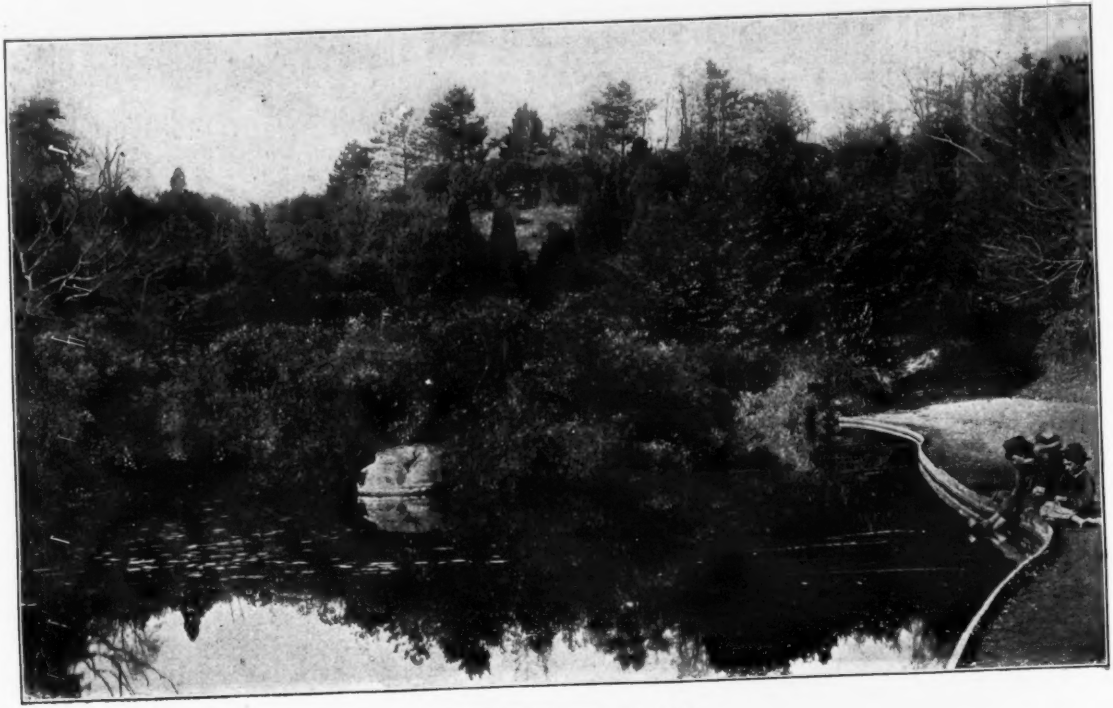


PROSPECT PARK IN 1860—VIEW FROM THE RESERVOIR LOOKING WEST.

to continue, if not to strengthen, for some time to come, and some bad effects are becoming apparent. Those cities are guided by wisdom which contrive a system of parks before the land becomes covered with buildings, for the cost when improved property must be taken is appalling to the tax-payers. Where it has already been done they are receiving liberal returns in the comfort, health and business prosperity of their populations. The inhabitants of Brooklyn will ever have cause to thank the projectors of Prospect Park for the good taste, sense and judgment they brought to the work. Those interested in similar work elsewhere will do well to study their methods and profit by their experience. They carefully studied the manner in which such work had already been done in other places, and thus were enabled to avoid useless work and expenditures that otherwise might have been incurred. It is said that the work was done more economically than has been the case in any other city, while no costly mistakes were made. Central Park, New York, which was then already well advanced, afforded the most useful object lessons, for it was not until the spring of 1860 that authority was first granted by the Legislature for laying out Prospect Park. Many of those employed in Central Park were also engaged here, and it is interesting to note a decided improvement in methods, resulting from their experience.

In all public works not imperatively demanded by commercial necessities or considerations of health it is difficult to interest the

THE MEADOWPORT ARCH.



THE VALE CASHMERE, PROSPECT PARK.

CLEFT RIDGE ARCH IN WINTER.

general community, no matter how much it is to be benefited, and a large amount of tedious, uninteresting and unrequited work must be done by some one. The preliminary legislation and acquisition of the land are of this character, and they are liable to bring disputes and difficulties regarding possession or boundaries that are far from pleasant to engage in. Politicians are never slow to interfere and damage the work, if by so doing they can advance their own ends. It takes far more than the endurance and patriotism of the ordinary man to persevere against such obstacles when engaged upon a work of philanthropy, or one intended to cultivate the taste and enlarge the artistic perception of his fellow creatures. Brooklyn was singularly fortunate in the character of its citizens who first actively advocated and advanced its park system. While avoiding the creation of oppressive burdens to the taxpayers, they realized that the demand for parks was a just one and should be conceded to the taste and spirit of the age. The fullest opportunity was given to all to express their wishes and opinions on the subject, which did not fail to call forth a great diversity of views.

The years following the inception of the park work, with the country in the throes of civil war, were not propitious for carrying forward such work, yet the commissioners busied themselves with the estimates and assessments necessary for the land taken, and the care and preservation of the trees and other desirable features already upon it. It was perhaps an advantage in the end that the delay occurred at this time, for by careful study and consideration it was seen that the location selected was not as good as

THE TERRACE IN THE GARDEN, PROSPECT PARK.

it might have been, and the landscape architects who were consulted pointed out how, by a change of boundaries, a much more desirable tract could be obtained, imparting additional interest and charm to the proposed park. The entrances were made finer and more accommodating to natural lines of travel, and the surroundings were improved for building sites and other uses of a great city. Becoming convinced of the soundness of these suggestions, the commissioners transformed the whole scheme, notwithstanding all the additional legislation, trouble and delay it occasioned. The city will ever owe a debt of gratitude to the men who so successfully advocated sound practice of landscape art, and whose good sense and nerve enabled them to acknowledge that the plans first adopted were defective, and to urge a change. The legal preliminaries having been completed and the financial pressure upon the country having been removed by the return of peace, the actual work of construction was commenced in 1866 and may be said to have been completed in 1874, although of course the maintenance calls for more or less constructive work each year.

The design for the work was prepared substantially as it now exists upon the ground. The main features are simple and easily comprehended. The existing natural qualities of the land were

A NOOK ON THE WATER.

LULLWATER, PROSPECT PARK.

VIEW OF THE GREAT LAKE.

everywhere accepted and made available and the necessary artificial constructions are nearly everywhere inconspicuous and in good taste. The most unique of the engineering constructions is a great well from which the entire water supply is obtained, excepting such as may flow into the water-courses from the surface. Water is so essential to the beauty of a park that it early occupied the attention of the engineers employed here, and there being no natural supply beyond that which gathered in pools during rainy weather, they were called upon to supply it by engineering methods, and the demand was most successfully complied with. Much of the ground covered by the park, and in fact the whole of Long Island, is one vast bed of sand, generally covered with a few feet of soil and loam. Consequently, although the surface drains rapidly, within the sand at depths from the surface averaging seven feet per mile above tide-water, is found a perpetual supply of pure water. A well having been decided upon, one was dug about sixty-five feet deep and nearly as much in diameter for the greater part of the depth. Into this the water pours at the rate of about nine hundred thousand gallons each day, and is pumped up to supply all the fountains, streams, and then the lakes in the park. In service a supply from the pump averaging seven hundred thousand gallons has been

THE STREAM, PROSPECT PARK.

found satisfactory, although, as an increased demand is anticipated, the question of an increased water supply is being agitated. The bottom of the lakes over almost the entire area excavated was composed of gravel and coarse sand, than which nothing can be more unsuitable for retaining water, and this had to be prepared with an artificial bottom of clay over almost the entire space. When the loss from evaporation and natural absorption is considered from the area of seventy-seven acres in lakes and water-courses, the success of these methods is remarkable, and the beauty of the waters most evenly maintained.

It seems ridiculous in these days to read the arguments once brought against the formation of parks in our large cities, by men of high professional repute, even within the memory of people who are yet young. They argued that "no police force could preserve decency and order in such broad spaces if the lowest denizens of the city were allowed access to them, and additional pleasure grounds would only give more room for riot and trouble. No gentleman would ever visit public parks or allow his family to do so." Those were the last of the days when parks for the people were fenced about and locked to keep the people out. No such unwise counsel prevailed in Brooklyn, for the public from the first were made to believe that the new domain belonged to them and were encouraged to make every proper use of it. The architect in charge studied how to make it popular and, while enforcing necessary regulations, endeavored to have them as few and as little restrictive as possible.

The result has been to create among the people a pride in the park and a fondness for it as a thing of their own, to an extent that I have observed in no other city. The park is visited by nearly thir-

DOWN AMONG THE ISLANDS.

AMBERGILL CASCADE, PROSPECT PARK.

teen millions of people annually, for its attractions alone, because it is little used in any part as a thoroughfare between different portions of the city, as is the case in many places. During a storm the place is as deserted as a wilderness, excepting for the guards, but within half an hour after the skies clear, the roads will be covered by carriages, or, in winter, with sleighs, while snow-flakes still linger in the air. As might be expected the greater number of visitors come on days when there are coaching or floral parades, school festivals and general holidays, but on pleasant summer days a hundred tennis-courts have often been in demand, and numerous amateur ball-clubs are watched by thousands of interested spectators.

Croquet still retains its popularity and among the unique scenes to be witnessed here are the games between clubs of white-headed old gentlemen, some of whom are justly proud of their skill. The mallets used are heavier and more solid than those usually seen, and the playing reaches a high standard of perfection.

Projectors of public parks should not forget the love people have of looking at each other, which the ancients believed was a gift from the gods, that we might never be without amusement. It seems equally strong in all races and nations and always manifests itself when people are at leisure to enjoy themselves. Seats where the passing stream of handsome horses and carriages with their occupants can be seen are always wanted, and spaces where the games and other amusements can be observed, if provided, will do away with what might otherwise be a tendency to injure some of the surroundings by crowding. Even in Prospect Park it was found desirable to increase the facilities in this respect. The bugbear of so many places, that the grass would be ruined if people were allowed upon it, does not frighten the park authorities. It has been found perfectly practicable to allow the free use of the lawns for games and exercise under a few restrictions. Permits are issued to use the tennis-courts, croquet and ball grounds and when they show signs of wear others are assigned to the players, and nature soon recuperates. The park is the favorite sketching ground for some of the foremost and best-known artists, and subjects for the camera abound in every part. Is it any wonder, when the people are made to feel they own the park, that they should rise in protest against the acts of vandalism by the authorities, as well as lesser ones by individuals, that have been attempted? The multitude of visitors shows unmistakably how welcome such breathing places are to an urban population, the genuine pleasure manifested

THATCHED SHELTER, PROSPECT PARK.

in the appearance of all, and, with few exceptions, the quiet and orderly behavior exhibited by the crowds of people so miscellaneous in character is remarkable. The efficient police superintendence adds much to the pleasure and comfort of visitors, and it has been remarked that the force is the most polite and agreeable to be encountered by visitors that can be found anywhere. They are instructed to assist visitors with such information, advice and guidance as may be required to enable them to see and use the park to the best advantage.

Good taste has been shown in preserving and marking the historic spot known as Battle Pass, which was consecrated by the blood of patriots on August 27, 1776. Four hundred men under General Sullivan defended this pass against the British from sunrise to 12 o'clock, under a galling fire of artillery, and most of those who survived this were cut down by British cavalry or bayoneted without mercy by the Hessians. In times when foreign influences are so dominant and American principles at stake, by recalling memories of a glorious past may those who see it be given hope in the future.

It is painful to observe that with the advantages of good design and construction and the great start given the landscape work, it is not maintained at the present time with anything like the skill and care that formerly characterized the management. Want of taste and comprehension of the intention of much of the original work is painfully evident. Beautiful effects that should now be reaching perfection are neglected among the trees and shrubbery and consequently the good of former work is lost. Groups and clumps have been allowed to crowd and smother each other and then most injudiciously cut out; others have become weak and straggling for want of renewal and care and are anything but cheerful to look upon. It is no wonder the reckless hacking in some parts should call forth vigorous protests, for when ignorance wields the axe everything is to be feared, yet nature wants assistance such as she no longer receives. The cause is not far to seek—appointments are made and labor employed, not for fitness and intelligence, but for political reasons, and Brooklyn suffers in her most beautiful part. If bad roads and ill-kept walks may be used as an excuse for a larger appropriation, we may be certain they will not be kept in repair. Yet skill and labor do not now cost what they did a few years ago. Inquirers from other places can learn that there are things to avoid as well as to imitate.

OLD GENTLEMEN PLAYING CROQUET, PROSPECT PARK.

PLAN OF
PROSPECT PARK
BROOKLYN, N.Y.
THE LONG MEADOW
RESERVOIR

When public taste in other cities forces its claims upon the public authorities they may execute works of art equal to Prospect Park and greater in extent, but it will ever be noted among the city parks for the most majestic views of land and ocean, great cities, and bays and harbors with their fleets of shipping and pleasure craft, more varied than can be found within the boundaries of any other city on either Continent.

PUBLIC ORE-SAMPLING WORKS.

By Albert Williams, Jr., E. M.

THE fundamental idea of sampling is simple enough. It consists in obtaining a small portion from any given quantity of ore which shall represent fairly the whole mass. This is done on the large scale whenever it is desired to get a just estimate of the character and value of a mine, in which case portions representing the whole cross-section of the ore exposed at different points are taken in a peculiar manner and these samples are then assayed or tested by a working process. Sampling is also performed on the small scale whenever an assay is made, for when a few ounces or pounds of ore are given to the assayer for determination, his first step is to procure from this a still smaller part—15 grams or a small weight called an "assay-ton"—for convenience in his work, and this last sample has to be a fair average of whatever is brought to him. The methods of sampling will vary according to the character of the substance in hand and the degree of accuracy desired.

But although the underlying principle upon which all the systems of sampling are conducted is so simple, the art of carrying it into effect rapidly, cheaply and with a fair approach to absolute accuracy involves intricate questions on the technical side; and though much thought and ingenuity have been brought to bear upon the problem there is still considerable difference of opinion among metallurgists as to the best means and methods. Any system is good that gives good results, and fortunately there is usually a ready check by which to test these results, by duplication of samples or by resampling by different methods. It may be sufficient to say that the essential prerequisite to perfectly fair work is to remove the whole operation from control of the judgment so far as possible. This is one of the cases where a machine is better than a man. The machine has no bias, has no knowledge of the value of ore, cannot distinguish color, and may be so constructed as to ignore, within limits, differences in weight and size of particles. So in all stages of the operation where man is obliged to take a hand, an expert sampler imitates the machine and endeavors to make his motions as nearly automatic as he can, for the moment

the least opportunity for choice or discretion is opened, then the "personal equation" of the manipulator enters as a disturbing factor. Hence, in that simple form of hand-sampling where the workman takes certain shovelfuls out of a large mass, he must not be allowed to select the shovelful to be retained for mixture into a common sample of the whole, but must take every fifth, tenth or other specified shovelful, just as it comes. For a similar reason the assayer cannot select by eye a piece which shall be a true average of a lot, nor can he assay the whole of it; hence the necessity for sampling.

When an ore is to be treated by the amalgamation or leaching processes, it either goes to the mill belonging to the mining company or is sent to a custom works where it is reduced, at a stipulated price per ton, by itself. In either case sampling is desirable, but not always necessary, as a check upon the metallurgical work. As the ore of each mine is then treated alone, and the works are cleaned up before and after each run, there is no confusion. But in smelting the situation is different. At present hardly any mining company operates a smelting plant of its own; and even if it did, it would be necessary to sample and assay everything just the same, in order to ascertain the kind and amount of flux to be added, as well as to know what the losses are. With very few exceptions ores are smelted in admixture with other ores, to minimize the amount of flux and to secure the best working results, each lot of ore losing its identity when made into the furnace mixture. The business of smelting has fallen, therefore, into the hands of a few large companies which buy their ores from the individual miners or mining companies, the two occupations of mining and reduction being kept entirely distinct, with mutual advantage to both. Under these conditions careful sampling and assaying are essential to establish the market value of ores.

At first the sales of ore to the smelters were effected on the basis of the sampling done at the smelting works, and this custom is still a common one. If the seller is not satisfied with the results the smelter usually will resample the ore for him in his presence. But to avoid occasion for suspicion or disagreement, a class of establishments called, distinctively, sampling works, was started in Utah in the seventies. These crushed the lots of ore sent them by the miners, sampled them, and gave the owners of the ore a set of sealed bottles containing the samples, which would then be hawked about among the ore-buyers and smelters, who would assay them

and bid upon the lots of ore thus represented, the highest bidder taking the ore if the bid were acceptable to the offerers, who, of course, usually had other samples assayed for their own guidance. This was a step in advance, as it placed the sampling in the hands of disinterested third parties, who naturally would take pains to furnish reliable samples, since their business depended on their reputation, and any error would be detected on resampling and reassaying. But the system in this form was still far from satisfactory to either seller or buyer. The former had bother in personally conducting the transaction, and the smelters disliked assuming the trouble of assaying and bidding when there was no assurance that the highest bidder would secure the lot. Besides, samples so handled were sometimes "salted," and though any falsification would be discovered when the lot came to be resampled at the smelting works, it was still a possible thing.

So about eleven years ago a further advance was made when Mr. George W. Peirce and Mr. Robert Campbell, then of Blackhawk, Col., introduced the system known as that of "public" sampling works. This system has been developed until it is in a most efficient state. There are now in Colorado three public sampling works at Denver, two at Pueblo, and also sampling works at Leadville, Aspen, Silverton, Denver, etc., which usually buy ores for their own account, but at times, on order of the owners, conduct business in much the same way as the regular public sampling works, and the plan will doubtless spread to other States. Sampling and testing works of the usual character are situated in various parts of the mining areas and also at some of the large cities.

The function of a *public* sampling works, in brief, is to act as agent, on commission, for the miner in the sale of his ore. It receives the ore from the mine, crushes and samples it and has it assayed by a "public" assayer, reports to the owner, distributes samples and assay reports to the smelters, receives their bids, sells for account of the owner in the open market to the highest bidder, delivers the ore to the purchaser, receives checks from him, and transmits the net proceeds after settling freight charges and deducting sampling commission. The whole series of transactions is therefore simplified immensely, with great saving of time and annoyance. The sale is in the nature of a public auction. Returns are received usually in three to five days after the ore reaches the sampling works. All the smelters are free to bid, and most of them do so, as there is no withdrawal of the lot offered. The buyer

gets the best price for his ore, and the smelters are sure of fair competition.

There is an exception to this mode of procedure, in handling very small lots of ore. The smelters decline taking less than five net tons at a time; and when smaller amounts than this come to the sampling works they are sampled and assayed in the usual manner and are bought by the sampling works at its own risk, to be held until enough of these small lots are on hand to make up a salable amount of five tons or more, when they are mixed together, resampled and sold to the highest bidder for account of the sampling works.

The charge made for sampling is from 75 cents to $1.50 per ton, according to the amount handled, except for very small lots, on which a higher rate is placed. For ores especially difficult to sample, as those containing nuggety gold and wire silver, and those of very high grade, the charge is also higher. This commission covers the cost of handling, sampling, assaying and effecting the sale, and is the only direct expense incurred by the seller except for freight; though, of course, the cost of smelting is calculated in making bids. Should the seller dispute the report, which rarely happens, the works resample the ore and if found in error make no additional charge. The system of conducting business is practically identical in all public sampling works, though they differ in their technical methods.

Much ore goes direct to the smelters from the mines, some of it on contract as to time, quantity and grade; and private ore-buyers handle a good deal also. Through whatever channel ore that is sold passes, it must be sampled; and in either case the processes, though varying in details, are analogous. Free gold ores, however, that are treated in amalgamating mills, are not sampled; but the concentrated sulphurets from them are, though the latter, being already pulverized, do not have to be crushed, like raw ore.

Following the course of the ore from the mine to the smelter, by way of the public sampling works, the successive steps are about as follows:

The ore, as taken from the mine, is usually roughly classified by selection in the stopes or by hand-sorting outside into grades according to richness and also at times according to other characters. The same mine may produce free milling ore, ore containing sulphurets which are concentrated in the milling process, and

true smelting ore. Of the smelting ore part may be "dry" (siliceous) and part basic or even self-fluxing, but no distinction on this score is often made at the mine. First-class ore, concentrates and fine ore are put up for shipment in sacks made for the purpose. Those of canvas are 14 by 24 inches, and jute sacks are of the same size or 14 by 30 inches. The weight of a sack of rock will range from 60 to 150 pounds, averaging 100 to 110 pounds, according to the character of the ore. Very rich ore is sometimes packed in oil barrels or oil cans. Where there are roads the lower-grade ore that is still rich enough for shipment is hauled in wagons and loaded in bulk upon flat or coal cars at the nearest railroad. The sacked ore is "packed" by mules and loaded in box cars. A standard-gage box-car holds from ten to twenty tons of ore; a narrow-gage one seven to fifteen tons; and the average of all carloads is about fourteen tons. At or before the time of shipment the owner notifies the sampling works. The single lots handled are from a sackful to a carload or several carloads, up to 250 tons or more.

On arrival at the yard of the sampling works the ore is weighed on receipt on the platform and again when in the hand-cars or barrows at the automatic sampling machines. A moisture sample of fifty ounces, or a set of three, is at once taken, weighed, dried, and weighed again on the same scales, which at some establishments are provided with a graduated beam, the divisions of which show the loss in units and fractions per cent. without calculation. In the dry air of the West an ore may lose half of one per cent. moisture daily for several days. As the assays and bids are calculated on net dry weight, the moisture sample is important.

Concentrates, being already pulverized, can be sent direct to the automatic sampler or worked down by the intermittent shovel plan or the hand split-shovel. All ore in the shape of lumps has first to be crushed. It is not desirable, however, that the whole of it should be made fine, as it would be liable to be in part blown out of the smelting furnace as flue dust. The aim is to produce a medium grade of fineness, just small enough to make a fair sample at the first stage. The crushing is done by rock-breakers, followed by Cornish rolls. As from this point on the methods vary considerably at different works, it may be well to briefly describe separately the plant and systems of two of the sampling mills.

I. At this mill there are two breakers with 9 x 15″ and 7 x 10″ jaws respectively. These deliver into the rolls placed below, a pair

following each breaker. One set of rolls are 16″ face by 36″ diameter, with steel shells; the other, 16 x 20″, with chilled iron shells. The rolls run at about 150 revolutions per minute. Both pairs deliver stuff ½″ to ¾″, the breakers being set to feed properly. Part of the ore is of course much finer, depending on its friability and original condition. From the rolls the crushed ore falls into the boot of an elevator consisting of an endless india-rubber belt with steel cups, boxed in, which conveys the material to above the automatic sampling machines. In this mill the ore is not screened at this stage, the managers objecting to screens at this point on the score of the separating action; but is taken by an inclined descending chute from the head of the elevator directly into the hopper of the sampler. There are two samplers, of the same pattern (unpatented), locally called the Argo automatic split-shovel. Each sampler belongs to one of two sets of crushing apparatus, so that work goes on with two lots simultaneously. The hopper of the sampler contracts to a 10 x 10″ aperture and has a slide-gate at the bottom. Across the opening is the "split-shovel" proper, which is a narrow (1½″ and 2″) but deep iron chute, so shaped as not to clog. About one-tenth of the material falls into the split-shovel and is shot out to one side into a wheelbarrow; the rejected remainder falls upon an inclined steel apron and thence in the opposite direction into hand-cars or barrows, and is sent to the storage-bins.

The sample thus obtained, representing say a car-load, weighs about a ton or a little more. No attempt is made to secure a particular weight, but merely a convenient quantity. It is now taken to a sampling-floor, of which there are three—one covered with plate-iron, 18 x 20′, and two wood-covered, 20′ square. Here it is thrown by common shovels against a hand split-shovel and reduced to one-half, now weighing about half a ton. The floor-sample is next passed through finishing-rolls (12 x 18″, with chilled iron shells) set to crush to about 20-mesh, but not screened. A roll-sample is caught on a hand-riffle and reduced to about twenty-five pounds. The hand-riffle or splitter is a gridiron-shaped apparatus like that used by assayers, but larger, with alternate receiving-troughs and open spaces about 1″ wide; this is passed backward and forward under the stream of falling ore particles. The twenty-five-pound sample thus obtained is then taken to the "sampling-room," dried, and further pulverized in a small power-grinder of the coffee-mill style; then split down by a hand-riffle to about ten pounds, and, if necessary, further worked down on a steel

bucking-plate by hand until all will pass a brass wire-screen of 80 to 120 meshes to the linear inch. The final samples, twelve in number, weighing about four ounces each, are caught by sifting over a dividing apparatus consisting of a series of equal metallic troughs, something like the hand-riffle just described. These are made up into packages, and with them is a label giving the serial lot-number. The distinction between "originals" and "duplicates" is begun from the sampling-floor.

This mill is equipped with a 70-horse-power horizontal non-condensing engine and 80-horse-power boiler. All the belts are of india-rubber. The yard covers five acres. The buildings are an office, mill proper, 108-bin house, 50-bin house and 12-bin house. Tracks are standard-gage and three-rail. One locomotive and ten cars are employed. The crushing capacity of the plant is 150 tons in ten hours, and the works can handle 600 tons daily of crushed ore. In 1891 there were 3100 carloads sampled, or 130 tons per working day. The miners received for this ore $3,527,862, an average of $87.54 net per ton, for gold, silver, copper and lead contents.

II. Another sampling mill resembles the foregoing in its crushing plant, having two rock-breakers, 9x15″ and 4x8″ jaws, crushing to 1″ and ¼″ to ½″ respectively; one pair of Cornish rolls 18x30″ with chilled iron shells; also, smaller finishing rolls. The power for this machinery, elevator, etc., is supplied by a 40-horse-power non-condensing horizontal engine and 60-horse-power boiler. The elevator feeds into a revolving cylindrical screen set above the hoppers of the automatic samplers. The screen is 3- and 4-mesh, and what does not pass it is returned automatically to the rolls and reground. Two automatic samplers, set side by side and boxed in, are employed, one at a time, the elevator and screen delivering to either as desired. These machines are of the "pipe" class (unpatented) devised by Mr. Peirce, having a tall, vertical wrought-iron pipe provided with four sets of quartering sections. Half the ore passing down the pipe falls upon two opposite inclined iron sectors from which it is shot out through openings in the side of the pipe and delivered to the bins. The other half falls through the alternate quadrant-shaped spaces, and on to the next quartering section, which is identical with the upper one in shape and action, opposite quarters of the ore being rejected as before; then through a third and a fourth splitting device of the same construction. Thus the portion saved is one-sixteenth of the lot under treat-

ment, and for a carload will weigh something under a ton. This is taken to the iron sampling floor, coned, spread with hand shovels, split by quartering, opposite quarters being saved as "original" and "duplicate," and these further quartered down separately, until a floor sample of about 100 pounds is taken from opposite quarters. The operation of hand-quartering requires skill and care, and is not easily described. The 100-pound sample is then put through the finishing rolls and screened to 40-mesh. It is further reduced by a riffle halver and ground down on a bucking-plate. The final sample of three to five pounds is divided into sixteen packets (eight originals and eight duplicates).

It may occur to the inventive reader to ask why all these successive steps cannot be simplified and the whole thing be done by one machine at a single operation. The answer has been partly suggested in the previous statement that it would be objectionable to pulverize a whole carload sufficiently fine for the last stages of the process, because it would not be in a good shape for the furnace. Such fine pulverizing and screening, involving a preliminary drying of the whole lot, would be expensive and tedious; and, besides, a partial separation of the richer and poorer material would be likely to be the result. Yet the final samples must be in a very minute state of subdivision. The difficulty is avoided by reducing quantities and increasing fineness *pari passu*. The first rough sample from the automatic machine must be a rather large one (about a ton from a carload), because the material at this stage is of widely-varying fineness or coarseness, from an impalpable dust to pieces $\frac{1}{4}''$ and sometimes up to $\frac{3}{4}''$ across, and a small sample would not include fair proportions of the different sized particles and pieces. The ore proper being usually more friable than the gangue minerals, the finer particles are the richer, except in the case of ore containing native metals. The degree of pulverization and the weight of the sample at each stage therefore bear a certain indefinite ratio to each other.

It is but fair to explain that machines for bringing the rough sample down to from a pound to a few pounds at a single operation have been invented. Among them is a recent device of Mr. H. C. Bridgman, of Blue Island, Ill., which acts on a contrary principle from that of the pipe and the split-shovel samplers. These take part of the stream of falling ore during the whole time; while the Bridgman machine takes the whole stream for part of the time. This is done by passing the coarsely-crushed ore through three successive

sectional "apportioners," of which the top and bottom ones revolve in one direction and the intermediate one in the opposite direction, the speeds increasing from top to bottom. It is designed to take double samples of 1 to 2 per cent. from lots of any quantity, these samples being further reduced by secondary appliances. Machines reducing the bulk of material so rapidly have an advantage in point of capacity and economy, and are said to work well with iron ore, copper matte and low-grade material of tolerably uniform tenor. But since the inventor proposes, for higher-grade and irregular ores, to adopt modifications which result in giving large rough samples (640 to 1280 pounds, for example), the work of the machine would then quantitatively resemble that of the older appliances giving large samples.

The probable error in sampling varies with the character of the ore, as well as with the care with which the operation is performed. For ores which lend themselves best to the process the error (if the work is properly done) is not much, if any, greater than the errors in assaying, which latter also may depend partly on the assayer's last sampling. With easily sampled ores, if an "original" assays 101 ounces silver per ton and its "duplicate" 99 ounces, it will generally be safe to assume that the truth is very close indeed to 100 ounces, and as a matter of fact the results commonly agree more nearly. But if there were much larger discrepancies, it would not do to accept the mean. The error might be due to the sampling, or to the assaying, or to both; or, while one result might be nearly correct, the other might be far astray.

Very high-grade ores require especial care. If they contain nuggets or wires of gold or silver, the whole lot may have to be ground down until all particles pass an 80-mesh screen or finer; as was done in a recent case after a discrepancy of 68 ounces per ton was shown in the first samples. Ocular examination of the ore generally will decide whether special precautions are needed. Ore of a clayey or talcose nature and very moist ore give trouble. The easiest ore to sample is that in which the mineral is pretty evenly distributed through the gangue matrix, and presenting no mechanical difficulties in crushing and screening.

Great care is exercised to keep the apparatus and sampling floors clean. If a rich ore has been put through and everything is not scrupulously cleaned up after the run, some remaining particles of it may get mixed in with the next lot and raise the average of the latter. Wire brushes, etc., are therefore diligently employed.

Sometimes barren limestone has been sent through the breakers, rolls, etc., to carry off adhering ore particles. Another plan is to run a certain amount of ore from the new lot through the machines, and not use it as a sample. But such a construction and arrangement as will allow every piece of apparatus to free itself, or at least be easily inspected and cleaned, is better still.

It may be added here that in Colorado an ore from a district comparatively near the smelting centers will have to carry about twenty ounces silver or its equivalent in other metals, and from remoter districts twenty-five ounces, in order to stand freight charges and deduction for expense of smelting, and leave margin for anything of a check to be sent back to the shipper. The average value of the ores smelted in Colorado is between $50 and $60 per ton, inclusive of gold, silver, lead and copper. But the average tenor of the ore handled by the sampling works is considerably higher. The low-grade ores usually go direct to the smelters. The iron ore used as flux is also argentiferous, that carrying seven to eight ounces of silver and in excess of 40 per cent. iron being in demand.

The assaying is done by assayers not connected with the sampling works. In case of a disagreement between their results and those of the smelters' assayers an umpire assayer is called in. At the smelting works the ore is not only assayed for gold, silver, copper and lead, but is further analyzed for zinc, iron, silica, lime, etc., to determine fluxing requirements. Sets of samples are given the shipper and also retained at the sampling works, besides those sent out to bidders.

The sampling works statement sent out in offering lots of ore for sale to the smelters gives the lot number, district from which received, character, gross weight, and assay contents in gold, silver, copper and lead. The report made to the shipper states lot number, gross pounds, percentage off for moisture, net pounds, description, assay contents in gold (ounces per ton), silver (ounces per ton), copper (per cent.), lead (per cent.), to whom sold, price per ton and total, New York quotations of the day for lead and silver, deduction for freight charges, deduction for sampling charges, and net proceeds.

The ore handled by the public sampling works in Colorado comes from all the Western mining States and Territories, British Columbia, Ontario, Mexico and Central and South America.

PESSIMISM OF MODERN ARCHITECTURE.

By J. H. Edelmann.

THE pessimism of our architecture is so generally considered as a mere matter of utility that it will seem strange to many to read of emotional expression as an element of architecture. Yet emotional expression is the very essence of architecture, and alone distinguishes it from mere engineering, where material expediency and convenience are the standards. Even engineering works are being brought under the sway of emotional criticism, since a bridge is condemned as being "ugly" and engineers are constantly attempting to make their works beautiful or at least inoffensive. The most uncultivated person speaks of "looks" as an important quality of a house; indeed architectural beauty has a money value. The attempt to meet the emotional want has in all times and places produced architecture in our country, as in all others. The emotions that lead to this outward expression are reflected therein and to the sensitive eye give in turn the truest picture of the people whose architecture remains as their record.

In the old colonial houses now so much admired, the simple, well-arranged buildings, with their few but well-proportioned details, their neatness and general air of comfort, certainly speak of a people living well-ordered, comfortable lives, competent and even accomplished in their limited range. Take a later period—that of the war and before the "seventies"—with its large, badly-constructed, ill-arranged buildings, aping all manner of ancient styles, covered all over with ill-assorted tawdry detail and badly-rendered and worse-designed ornament. Are they not eloquent of a people intoxicated with material wealth finding their emotional expression in lavish vulgar display? The buildings of that time, should they survive, would surely tell their true story to a future investigator—the story of a people who believed that money would buy everything, art included, and that a skilful buyer could even cheat in the buying and get fine art at a bargain.

We are not yet wholly out of the latter stage. Evolution does not advance in solid front. The vast bulk of our American architecture is as yet in the bargain-counter stage. Every season or

two styles change, and clever financiers drive hard bargains in architectural beauty with clever shop-keepers who supply and often create the demand. But the quality of the wares is constantly improving; ever and again an architect escapes from the thralldom of shop-keeping to become an artist, and finds clients instead of customers. This advance is on two lines—scholarship and invention. All study more carefully the great works of the past. One school finds its models in the classic architecture of Greece and Rome, another in the Renaissance; these in the Gothic, the Romanesque and the Moorish. The whole world is ransacked. Even the gentle Japanese are investigated by ardent enthusiasts who hope to transplant the only living national art to our own country.

Of those who seek their inspiration in the past, Mr. Stanford White stands at the head. His "Giralda Tower" is a work of art, complete and harmonious—not a slavish copy but a reproduction in form and spirit—a piece of old Spain transplanted to America, an exotic not rooted in our soil, giving only negative expression to American ideas. Infinitely more crude are the works of those who strive for originality, who dream of an "American style" to be presently invented, or boldly accept local conditions and requirements and wholly ignore tradition and scholarship. The painful results we see in every American city, especially in commercial building, where the supposed necessity for light and the use of cast-iron have resulted in a class of structures "without visible means of support." But they are alive, these childish, brutal, vulgar designs; they spring from the soil and foreigners recognize in them the "American architecture." When all the elements have been distilled in the alembic of a great artist's soul we shall have a true national architecture.

The great artist embodies in his work, be it in painting, literature, music, or architecture, his own personality, his own ideals, but these in turn embody the hopes and fears, the aspirations and regrets, the unconscious ideals of his contemporaries. In the works of a great artist, people find themselves and lesser artists unable to translate from the original book of humanity and adopt his form of expression. Richardson was undoubtedly the first great American architect. He alone founded a school, he alone has been recognized abroad as an artist distinctly American. In his work and to some extent in that of his disciples we shall find the authoritative American expression. Richardson, it is true, used

the Romanesque of the south of France, but he used it only as a point of departure ; he was not a pedant and never permitted his scholarship to limit his freedom. Of the characteristic qualities of his work the first is simplicity. His buildings are not "cut up"; there are few parts; he delights in large masses, in huge forms, austere outlines ; his walls are cyclopean. His rude simplicity is even ostentatious, so that one suspects him at times of playing a part and of laughing in his sleeve at the gravity of the audience. His detail is coarse and meager, but it is not essential to the effect.

Richardson's earlier work was not in commercial building and doubtless this was fortunate, for business is a hard and hostile master to the artist. His first business buildings were comparative failures, both practically and in artistic expression, but even this field he made his own and his wholesale store for Marshall Field, in Chicago, marks the type—a grim fortress of trade—disdaining all petty subterfuges and make-believes of design. He gives us a huge square box with regular ranges of openings for light—massive, simple, brutal, naïve, the true expression of its inward character. In his Pittsburgh Municipal Buildings he was not so rigidly bound by practical requirements. Here we find a distinctly romantic element. There is a huge tower wholly emotional, and much of the grouping and even planning is independent of utilitarian considerations, but the result is even more pessimistic. The City-Hall is still more hostile than the jail. Its mighty walls, its lofty towers and ample roofs greet the beholder with no joyous air. We admire it as we admire a work of Zola's—we praise the artist, we cannot resist the subtle fascination of truth, even though it be painful.

But the insight of a great artist is not transferred to his followers. Richardson's work always commands respect while that of his imitators creates amusement and disgust. The mere outward forms are copied and misapplied, his faults are exaggerated ; it becomes a fantasy of crude eccentricities ; brutal strength devolves into brutality, and so while the last of his work is barely completed his school is already in decadence. His early death was an irreparable loss. Had he lived he doubtless would have attained much higher power of expression, and made a permanent impression on our architecture. As it is his influence is waning and will soon be but a reminiscence.

To the present writer it seems that a new master has arisen, not

popular as yet, but destined to leave the impress of his personality on our architecture. Mr. Louis H. Sullivan has, in my judgment at least, an even deeper insight than Richardson and greater power of expression. It is only fair to say that the first work that brought him into general notice, the Chicago Auditorium Building, was distinctly Richardsonian. Although the detail is most individualistic, detail is lost in the huge mass. The tower which marks the passage that pierces the girdle of commercial structures encircling the half-commercial auditorium and which was designed doubtless to mark emotionally the entrance, is itself profitable to the very roof, and the emotional expression of the whole naturally rises no higher than the commercial ideal.

Great size, simplicity, insufficient means, pride of attainment, unbounded ambition, are the qualities expressed, and the soot-laden atmosphere throws a grey shadow over all that well corresponds to the cynical pessimism of the society it serves and exemplifies. But this work is but the germ swiftly ripening to complete development.

A long series of buildings could be named, each more and more nearly approaching that complete unity in function and expression that marks the masterpieces of architecture. I select the Wainwright Building in St. Louis as the most complete expression of American commercial architecture. Observe the complete absence of all conventional forms. While in the East our most clever men are still building up their lofty structures, by super-imposing (intellectually) several old buildings one upon the other, and making serious sacrifices of structural convenience to vertical divisions into bays, pavilions, towers, etc., here all this is brushed aside and the rectangular steel skeleton is expressed in rectangular outer forms. The building is treated as one essential and integral growth. Instead of concealing the simplicity of internal function it is emphasized by repetition of parts; instead of minimizing the height by horizontal divisions into three or more fields the height is made the artistic motive. Nothing could be more simple—or obvious—now that it has been done; the years and lives have been spent in vain attempts. The main piers are carried up through the first floor, the large openings covered with flat arches, the entrances marked by decorative carving, the story topped with a simple string course which marks at once a change of internal function. Then the whole vast range of stories—having common uses—are treated alike, with only minor differences of detail; the vertical

lines are clear and distinct and in themselves give a strongly emotional expression, and finally the last story is frankly sacrificed for a frieze of marvellous design pierced only by circular openings of small value as windows, and all surmounted by a broad, straight cornice richly decorated in unconventional fashion. Here a great problem is solved. Commercial architecture is revealed, no longer a thing of shreds and patches and shams, but direct and complete in itself—an embodiment of truth—of most sinister aspect.

The recent climax of the spirit of commercial architecture which aspires ever higher in its search for the "Ultima Thule" of profitable exploitation of the upper air, in a thirty-four story building, fortunately has found artistic embodiment at the hands of Mr Sullivan, for he alone could do it artistic justice. Here the necessity for leaving air to breathe and some light at least for the occupants of the lower stories, has led to new features in the design. Even the broad Chicago streets will not suffice for thirty-four-story structures built vertically on the street line. Hence we see open exterior courts and a pyramidal form with the apex in the center of the plot. A recent criticism spoke of this project as a "child's building-block design," and that is just what it is. The unit of structure is a room, the lines of the steel skeleton are rectangular, and consequently the masses must be aggregations of cubical forms and the light courts be cubical voids. The question is shall the exterior design be an attempt, and necessarily a futile attempt, to conceal the truth, or a frank avowal of it? The designer has taken the latter view, and has succeeded in embodying here in the rigid framework of utilitarian requirement the most subtle and spiritual potentialities of the problem. To say that the expression is pessimistic is to express an obvious truth, and this despite the fact that the highest skill has been brought to the task.

To construct such a building requires a vast social organism. The materials are literally brought from the ends of the earth; an army must be employed; the various intricate and complex parts most accurately foreseen and adjusted. The display of intellectual skill and power raises one's idea of human potentiality, and finally the artistic inspiration that can blend so mighty an array of hostile forces into one vital, living whole is nothing less than genius. Yet may we exclaim: "If this is to be our future in architecture, well may we regret our rude and buoyant youth, ere we had brought accomplishment, high aims and subtle insight to the service of the prevailing money cult."

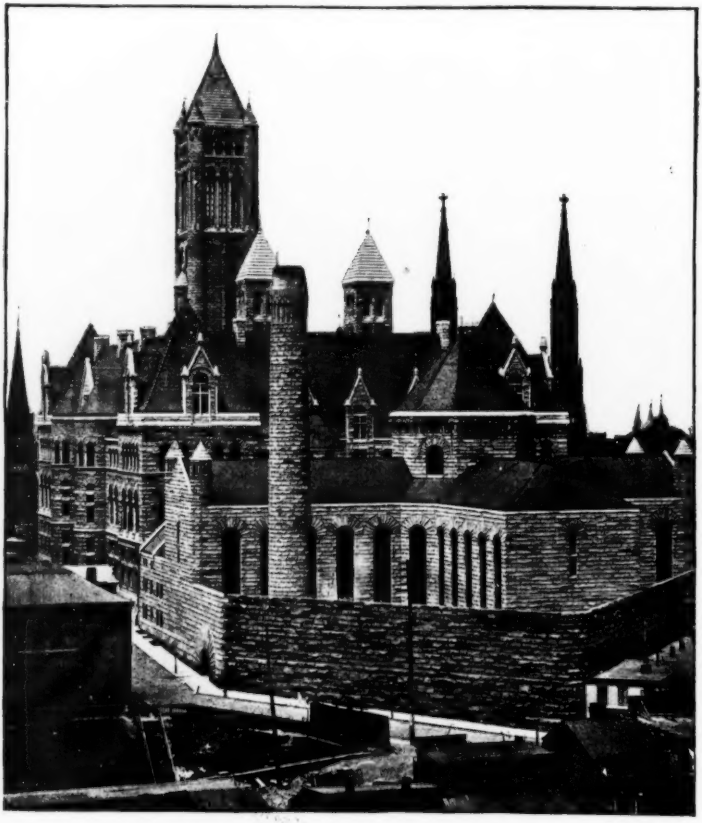
THE WAINWRIGHT BUILDING, ST. LOUIS—RICHARDSON, ARCHITECT.

But not in huge mass and general form alone does this sadness of expression in our national architecture extend; we feel it in detail no less. Ornament, which has no direct utility and is primarily emotional, surely should stimulate only pleasant emotions. How is it in reality? In our earliest work we find a few stock designs of classic origin, always well executed, often graceful, never vulgar—we feel that we have to do with competent, self-respecting workmen and appreciative and discriminating employers. But when we enter the era of manufactures, of commerce, all this is changed. If a little decoration is a good thing a great deal must be most excellent, and labor-saving devices presently furnish the desired abundance. The scroll-saw inundates the land with alleged ornament in wood, cast-iron duplicates of carving and statuary, pressed zinc detail, galvanized-iron cornices, and imitations of all sorts—and all "superior to the originals"—make us opulent of the art achievements of all ages and all peoples.

Some of our good folk are still enjoying this stage, but a growing minority demand something better. Corresponding to this demand we have stained-glass work of great merit, largely original because largely personal. To John Lafarge and Mr. Louis Tiffany and a few others we owe thanks for the beginning, and this the more since one can truthfully say that this branch of American art is not deeply tinctured with melancholy. Here we have again the old artistic spirit not wholly subjugated by business policy. In general decoration our best work is not original. We have again acquired the skill to copy faithfully and to use with taste the work of by-gone days. But this will not satisfy the imperious demand for personal and contemporaneous expression. Crude, even vulgar, though its first fruits be, the American life of to-day makes itself felt in decorative work. And why should we not look forward to its full fruition with joyful anticipation? Because this is a commercial, not an artistic age.

Let us examine the society that produced the great works of the Gothic and the early Renaissance styles. They were the work of cities that in their prime, at least, were intensely democratic communities. They were organizations of free workers proud of their skill, jealous of their reputations as craftsmen. The affairs of each trade or "mystery" were managed as a whole; the price and quality of the product, the number of journeymen and apprentices allotted to each master, all were regulated in the common interest. Processes were simple, machinery all but unknown. The

GERMAN OPERA HOUSE, CHICAGO—ADLER & SULLIVAN, ARCHITECTS.

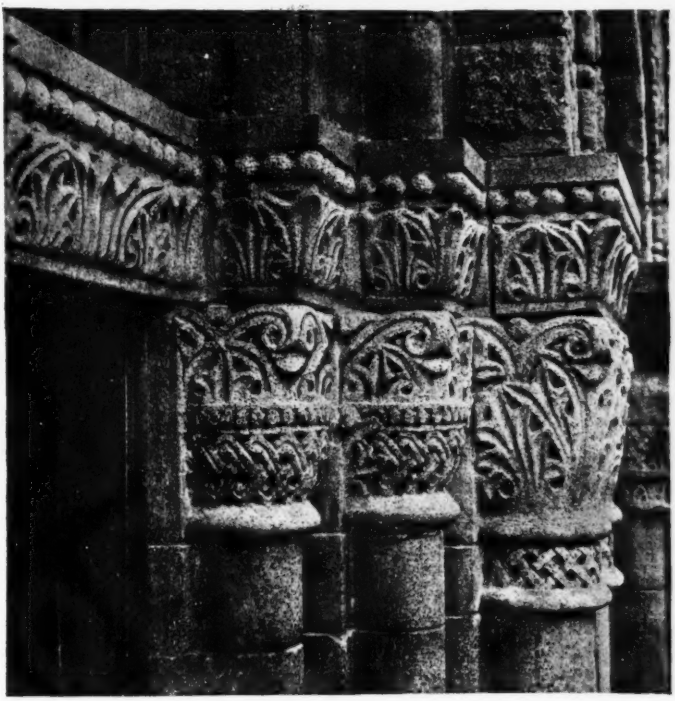


ALLEGHENY COUNTY COURTHOUSE AND JAIL, PITTSBURGH.
[Copyrighted. From the "American Architect."]

architect was simply the master-builder, and each craftsman who wrought a part brought ample skill and craft pride to his task. All worked in a common style, the prevailing one of the hour, and all lived lives of jovial abundance, free from the fear of want. Small wonder then that in the works of that time we find our ideal of artistic perfection to which we vainly aspire. They were the works and they are the monuments of a society as dead as the megatherium.

Contrast our own social conditions. Our craftsmen are politically free and highly-educated men, in theory at least. Economically—that is to say, actually—they are mere wares subject like other wares to the law of supply and demand ; they are bought for the work they can do. Their interest is of course to give the least in exchange for the purchase price—*i. e.*, the wages. And this view is enforced by the trades unions to which they must belong, for these unions know that increased efficiency of labor must, on the whole, lower wages, and hence do not encourage it.

The architect, himself almost always a ware bought and sold in competition with other wares, harassed by a thousand uncertainties and perplexities, gives what energy he can spare to his



FROM THE CHAMBER OF COMMERCE, CINCINNATI.

[From the "Inland Architect."]

life as an artist. He must pre-determine the exact form and shape of his buildings, specifying all material and labor, minutely describing all constructive forms, working out all decorative detail from the standpoint of money cost at least. For the building itself is a ware and its price is to be settled by competition. The *lowest*, as a rule, is the *best*, bidder, and "if t'were done at all t'were well it were done quickly," for "time is money." If the architect is a man of extraordinary force and enthusiasm he will, nevertheless, work out his design, with vast and loving care, securing the co-operation of young and ardent assistants who work as much for love as for money. But even he will find the execution in the hands of a contractor to whom profit is the first law, which, on pain of ruin, he dares not disregard, and finally of workmen who cannot be expected to hold their work as higher than themselves, and they are wares. Can we reasonably look for art work from a commodity? It is only wonderful how much we actually receive. Humanity is not to be wholly expressed by the formula of trade, and people will after all give more than is paid for.

I have spoken here only of American art, but the world over the old joyous art is dead. Even in Japan it is dying and from modern commercialism no happy art can spring. If this phase of civilization is to prevail Pessimism must become its final expression and embodiment.

WORK IN THE NEW YORK TRADE SCHOOLS.

By Leon Mead.

MANY rich men in America, when asked for advice to young aspirants to wealth and position, offer it in words akin to these: "Learn a trade; there is not an even chance for you in the professions; ninety-five per cent. of those who try to succeed in business fail." No one can gainsay the truth or wisdom of all this, though it must be conceded that the aspirant, in the long run, must judge for himself and act upon his own responsibility.

Men who have secured a competence through their own exertions not only recognize the dignity of honest labor, but they appreciate the practical value of the knowledge of a trade to their sons who are about to take upon themselves the substantial burdens of life. How much more alluring then to the son of a poor man must be a skilled trade, which, on account of the grim actualities of his struggling environment, it shall cost him vast effort and perhaps great self-sacrifice to acquire. Since both rich and poor acknowledge the benefits of manual-training for young men, it may be that trade schools will yet become essentially vital to our national existence. That we cannot well do without them is already apparent to all who have given the subject intelligent attention. There is no lack here of opportunities for intellectual development. Young though our Western republic may be, we have moss-grown, ivy-clad colleges wherein the classics are taught; we have art schools and schools of law and theology, and medical universities whose students are taught more than Æsculapius himself ever dreamed of; we even have schools where the *soi-disant* farmer may, or may not, learn scientific as well as practical agriculture, besides schools of telegraphy and book-keeping and what not. But schools for the mechanic arts are not numerous in the United States. They never have been endowed and fostered in this country as the classical, collegiate and professional schools have been nor have they been deemed of sufficient importance to enlist—barring a few notable exceptions—the interest of philanthropists.

The skilled labor of this country to-day is performed largely by foreign-born workers who, as a rule, had the advantages of

trade training before coming to these shores. In Europe trade schools have flourished for many years. They include the London Guilds' schools, the Paris schools for the building trades and for workers in wood, metal and leather ; the Imperial Technical School at Moscow, and the magnificent schools at Crefeld and Chemnitz, in Germany, and at Verviers in Belgium. Then in Berlin is the famous blacksmiths' school, where many of the young army blacksmiths receive instruction. The London Polytechnic Institute furnishes industrial training to young men of from seventeen to twenty years of age, who have received an education in the public schools or at college.

While industrial schools are yet comparatively few in the United States, their general establishment seems merely a question of time. At the recently-inaugurated Drexel Institute, in Phila-

BUILDINGS OF THE NEW YORK TRADE SCHOOLS.

delphia ; the Pratt Institute, in Brooklyn ; the Worcester (Mass.) Free Institute, and at certain colleges endowed by the United States Land-Grant Act, trades are taught—mainly to beginners. Young colored men are taught trades at Hampton, Va.; at the Clark University, Atlanta, Ga., and at Central Tennessee College, while at Carlisle Barracks, Pa., young Indians are afforded similar instruction. At certain other educational institutions as well as in numerous reformatories in different States several trades are acquired to a limited degree of proficiency, and a number of large private manufacturing concerns provide instruction for their own employés. The Carriage Makers' Association of New York, for instance, maintains a school for young men employed in carriage-building and in several cities the "helpers" are provided instruction by the Master Plumbers' Association.

But the model institution in this line is the so-called New York Trade Schools, established ten years ago for the purpose of giving young men instruction in certain trades and to enable young men already in those trades to improve themselves. The founder of these schools and the originator of the system of trade instruction pursued there is Colonel R. T. Auchmuty, a retired architect and a man of wealth and prominence in educational affairs. Colonel Auchmuty is a practical philanthropist as well, and it was his conviction that the workshop does not and cannot teach all that is essential to an education in the mechanic arts, that led to the

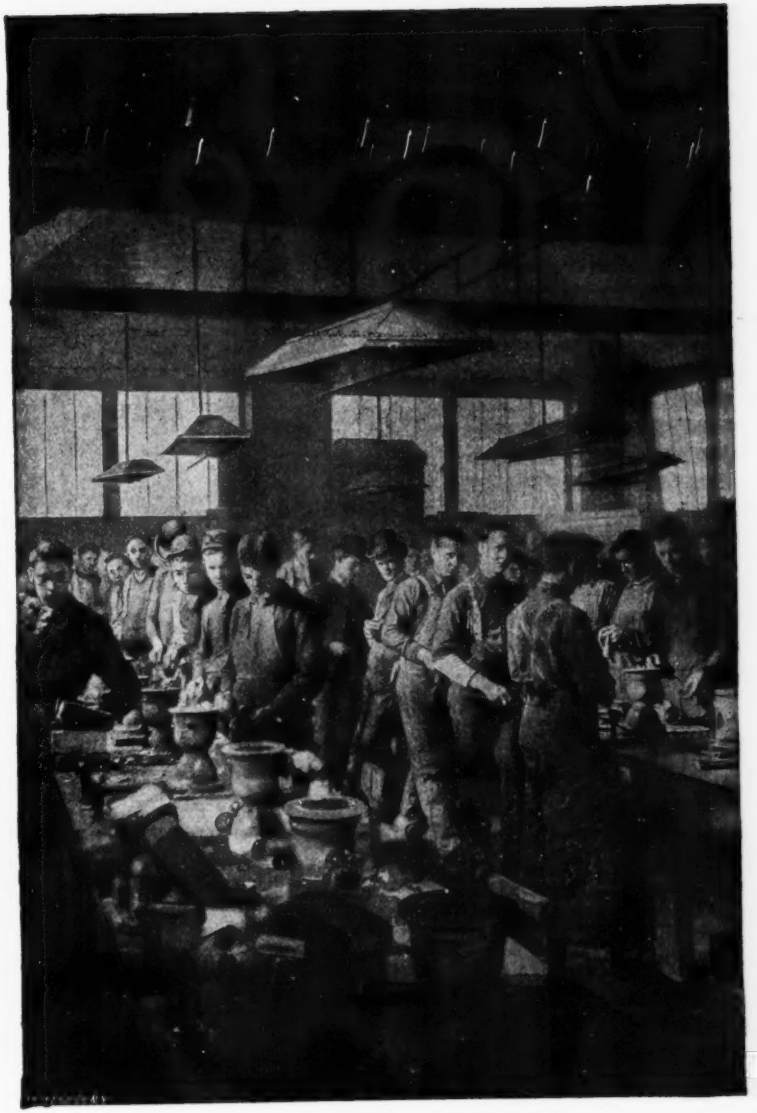
SPECIMEN OF WORK BY THE BLACKSMITH CLASS.

establishment of the New York Trade Schools, where both the manual and scientific instruction should be thorough.

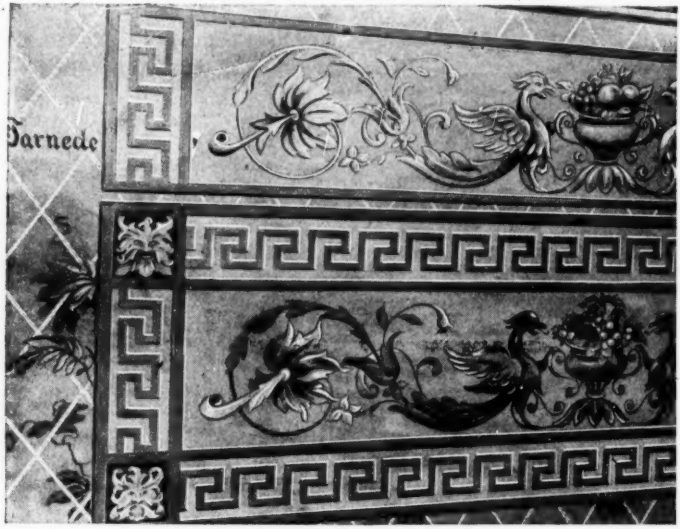
It may be observed here that the prejudice hitherto existing against trade schools in this country has been due chiefly to the now fast-decaying system which was born during the reign of Queen Elizabeth, who affixed her name and seal to the so-called apprentice laws. But the diffused employment of machinery and modern methods of labor have practically revolutionized the old apprentice system. The employer or master can no longer give his personal supervision and attention to the prentice, who may be more of a nuisance than a help in a busy shop where skill worthy of its hire is required. Therefore, as Colonel Auchmuty in several

public addresses, and others who are versed in the matter, have pointed out, the apprentice is left more and more to his own expedients, and the training he acquires in a workshop to-day is largely the result of chance. In other words, the apprentice is liable to only half learn his trade. It has been demonstrated that more can be learned at a good trade school in three or four months than is usually acquired in as many years in a workshop. At the same time it is admitted that the trade school, even at its best, has its limitations, and when it reaches that measure of efficiency where it shall do for the mechanic arts what the professional school is doing for the professions it must still leave, after it has thoroughly taught how work should be done, the rapidity and dexterity required of a first-class mechanic to be acquired at real work. In short, experience must be added to skill in order to produce a master mechanic. It is generally agreed that a combination of the trade school and the workshop would be the nearest approach to an ideal apprentice system. This idea has been recommended for adoption in the building trades by the National Association of Master Builders, but thus far it has been only partially realized.

The New York Trade Schools occupy a plot of land measuring 200 feet on First Avenue, 188 feet on Sixty-Seventh Street and 113 feet on Sixty-Eighth Street. The buildings are one story in height, except on Sixty-Seventh Street, where the slope of the land allows a basement floor. The main entrance on First Avenue leads into a capacious, substantially-furnished hall on whose walls are suspended photographs of groups of young men who have attended the schools; also views of several buildings erected by members of the bricklaying class. Beyond the hall is a small court communicating with the different shops which, for the most part, were built by classes in the schools. Open to the roof, the workshops have windows on three sides, thus securing adequate light and ventilation. New workshops, each 37 feet wide by 115 feet in length, to be used by the plumbing and carpentry classes, have been completed lately. From 6 to 7 o'clock in the evening the well-supplied reading-room is open to members of the Schools. It is used also as a waiting-room by those who come before the workshops are open. Its use during the day, and after 7 in the evening, is reserved for members of the day classes. The evening instruction includes courses in fresco painting, blacksmith's work, carpentry, house and sign painting, bricklaying, plastering and plumbing. There are day classes in plumbing,



PLUMBING SHOP AT THE NEW YORK TRADE SCHOOLS.



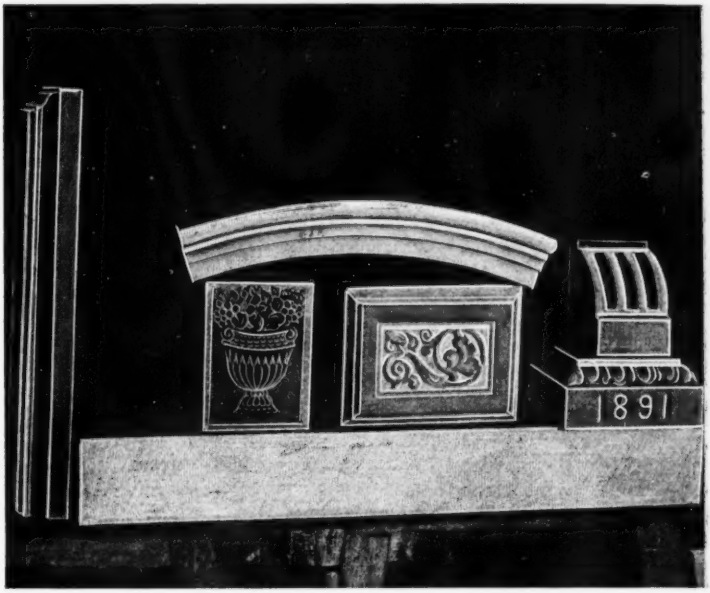
GLIMPSE OF FRESCO WORK DONE BY A PUPIL OF THE TRADE SCHOOLS.

house, sign and fresco painting, carpentry, stone-cutting and tailoring. The use of tools and materials is included in the charges for tuition.

The eleventh season of the Schools commenced on October 14 last. The expenses of the Schools last year, exclusive of interest on cost of land and buildings, taxes and insurance, were $18,755.78. For a corresponding period the receipts from pupils and the sale of old material were $13,599. Colonel Auchmuty's purse made up the loss; so that from the figures given it may be reasonably inferred that the genial Colonel is not endeavoring to make any money out of the establishment. With the reader's permission I should like to indulge in a few more figures to better illustrate the growth of the New York Trade Schools. The increase in attendance since the first season has been encouraging. Only thirty pupils were enrolled when the Schools opened. Last year the membership, exclusive of the students of architecture of Columbia College, numbered 589 young men. The total number of pupils who have received diplomas is 3121. The evening classes have been attended by young men from neighboring places in Long Island, New Jersey and Westchester county. The day classes have been made up of

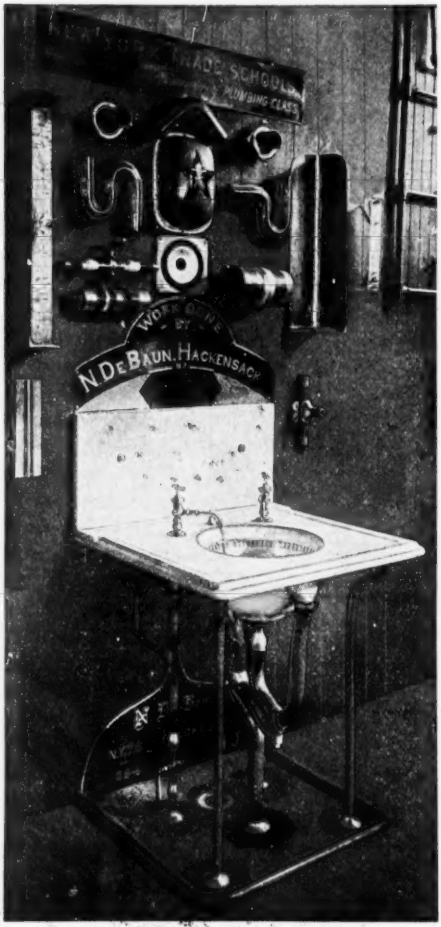
students from some of the remotest parts of this country, as well as from Canada and Nova Scotia. The system of instruction pursued is quite unlike anything heretofore attempted, and that it has attracted wide-spread attention both in this country and abroad is at least one substantial assurance in its favor. The teachers are all skilled mechanics—that is to say, in the departments of manual instruction. The scientific branches are imparted through lectures, hand-books arranged with questions and answers, and by diagrams illustrating not only how work should be done, but the difference between creditable and defective work.

The classes in bricklaying and plastering, under the direction of Mr. Erskine Van Houten, have five instructors. Practically the manual instruction consists in building eight, twelve and sixteen-inch walls; in turning corners and building walls intersecting at different angles; in building piers, arches, flues and fire-places; in setting sills and lintels, in corbelling, etc. Construction of flues, thrust of arches, mixing and properties of mortar, cement, etc., con-



ORNAMENTAL STONE-CUTTING DONE BY A PUPIL OF THE TRADE SCHOOLS.

stitute the scientific source. As a rule pupils have obtained full wages in from six months to two years after leaving the New York Trade Schools.



WORK DONE BY A STUDENT IN PLUMBING.

In the plastering department the instruction includes scratch coating, brown coating and hard finishing; also running and mitering plain cornices. Learning the plastering trade is not difficult, though it is declared to be hard work; for which reason, probably, efficient plasterers receive more than bricklayers.

The three-months' day course in stone-cutting, under the supervision of a committee belonging to the Master Free-Stone Cutters' Association of New York, is reserved for young men between eighteen and twenty-three years of age. The beginner is first given a rough, irregular block of stone to square. He is then taught the various ways of surface-finishing in brown stone and afterward receives instruction in cutting raised and sunken panels, simple and return moldings and chamfers. The terms for this course are $35, payable upon admission.

The painting classes are so divided that instruction is afforded

in house, sign and fresco work. A committee of the Master Painters and Decorators' Society of New York has supervision of this department. At the completion of the course an examination is held for the purpose of determining the manual skill and scientific knowledge of those who have pursued it, and certificates are given to the deserving members of these classes. A large wall surface, on which the young men are practised, is provided in the class-room. The fine-work instruction is facilitated by means of box shutters and wooden screens fitted with doors and windows. One of the illustrations will give the reader a very good idea of the

SPECIMENS OF WORK NOW ON EXHIBITION.

painting room. Judged by results the work of both the day and evening classes has been remarkable. The members have standing to their credit many excellent specimens of fancy painting, work in flat colors and polish white, as well as in graining, gilding and lining. Without previous knowledge of the trade when they came to the Schools, these young men have executed all this praiseworthy work. As in the stone-cutting class, the three-months' day course of instruction in house, sign and fresco painting is reserved for young men between eighteen and twenty-three years of age. The

terms are $40 for the course, and members of the class are entitled to evening instruction in sign painting. Mixing paints, preparing the surface for painting, the proper care of brushes and paint pots, are some of the features of manual instruction imparted. Later on, when the tyro can rightly indicate where to commence his task and can satisfactorily cover plain surfaces of wood, brick or tin, he is led onward toward the attainment of his trade by exercises in the technical matching of colors, in flatting, stippling and glazing. The

A CORNER OF THE CARPENTERS' SHOP.

scientific part of the course includes instruction in the intrinsic and relative properties of oils and dryers, and in the various materials used in painting. On Monday, Wednesday and Friday evenings instruction is given in house painting. Fifteen dollars are charged for the course. The sign painting class is given instruction on Tuesday and Thursday evenings. The applicant pays but $10 for the course, which for the current season extends from De-

cember 16 to April 7. Preparing the wood, spacing and plain lettering are first considered; then colored and gold lettering on glass and metal. In fresco painting, the terms of which are $12 per course, the class meets on Monday, Wednesday and Friday evenings. On plastered screens and ceilings the fresco painting is executed, after being prepared, of course, for kalsomine. As the student advances, as he learns how to line, to make and to apply pounce and stencil, to copy or create flat and shaded ornaments, he becomes a practical fresco artist.

In the blacksmiths' branch instruction is given on three evenings a week the tuition being $12 for the course of six months. The appliances of a first-class smithy, including forges and tools, are at hand to the pupils. Management of the fires, "drawing down," bending, shortening, welding, splitting, punching, riveting, chamfering, railing, etc., constitute the instruction in forging. In vise work the pupil is exercised in chipping, filing to line, fitting tongues and grooves, ring work, bevels, drilling, scraping, etc. In tool-making the principles of tempering are demonstrated and many kinds of tools are fashioned.

In carpentry and joiners' work there are two classes—limited to sixty members each—between sixteen and twenty-one years of age. The terms for the course are $16. Beginners are first shown the use of the various tools common to the trade. Then they learn to plane, to saw to a line, to do mortising and tenoning, to frame panels, to put moldings on them, to make doors and shutters, to set partitions, to lay flooring, and other varied work of this order. Former members of the carpentry classes in the New York Trade Schools have easily secured employment.

The plumbing classes—day and evening—under the supervision of the Trade School Committee of the Master Plumbers' Association of New York, have been conducted with more than ordinary success. The plumbing schools in various parts of the United States and Canada have adopted the system maintained here. The plumbing shop of the New York Trade Schools is capacious and amply equipped. Allotted his place at the work bench, each young man is furnished with a set of tools. The instructors are skilled mechanics and follow a prescribed course. Bunsen burners are used to melt the solder. The scientific course is elaborate in detail, for the successful plumber of to-day must know a great deal more than the plumber of even fifteen years ago. In the manual branch of this complicated trade he must be informed on

such matters as lead seams, calking, cap joints, overcast joints, wiping a flange on a two-inch pipe, etc. The two evening classes in plumbing are limited to seventy-five men each.

Instruction in mechanical drawing and in plumbers' bookkeeping is furnished to the day class, the members of which are occasionally taken on excursions of observation over different city buildings. They are required to set forth, according to the rules of the Board of Health of the city of New York, the specifications for an ordinary city house.

Lastly, the tailoring class is under the management of the Merchant Tailors' Society of New York, first-class teachers being employed. Instruction is given throughout the year, at a cost for tuition of $100, for a course of two years, if the examining committee find the pupil proficient enough to justify his continuing so long. Gymnastic exercises are furnished for the betterment of the physical condition of members of this class.

A building particularly erected for the accommodation of young men who come to New York to attend the Trade Schools contains comfortable, furnished, single rooms at $2 per week and double rooms with two beds at $3 per week. This building, No 300 East Sixty-Seventh Street, is not far from the Trade Schools. Meals in neighboring houses and restaurants are obtainable at from $3 to $3.50 a week. More luxurious accommodations than have been mentioned are easily accessible.

Through the New York Trade Schools, or any other intelligently directed institution of the kind, ambitious and reasonably capable young men can acquire in a short time and at a small outlay the knowledge of a trade by means of which they may be assured of a certain livelihood. More of the rising generation than are likely to do so should learn trades. Law, medicine and the other professions are overcrowded and unprofitable to the majority. In business the tendencies and malice of competition are to knock down profits to an almost starvation minimum. To be sure, there are great monopolies and into the spacious coffers of their managers a constant torrent of lucre is rushing, but I am speaking of general conditions—of the masses. On the other hand, skilled labor commands the highest wages all over the country and the demand for it far exceeds the supply and never was the demand so urgent, so inviting, in this country, as it is to-day.

WORTHLESS GOVERNMENT ENGINEERING.

A PLAN OF REFORM.

By George Y. Wisner, M. Am. Soc. C. E.

NO other civilized country in the world has such an incongruous system of public works—or perhaps it may be said, lack of system—as the United States. Our great national surveys are conducted under three different departments of the Government, under the direction respectively of military engineers, civil engineers and politicians. The work of each department is often discredited by the others, and is seldom planned with reference to any other needs of the public welfare than the immediate necessities of the department concerned. Expensive surveys are in consequence duplicated very frequently, and in fact it has been no uncommon occurrence to see engineering parties under the direction of the United States Engineer Corps and the United States Coast Survey engaged within sight of each other on work precisely similar in nature and purpose.

Our river and harbor improvements are conducted under the direction of a mixed corps of military and civil engineers, responsible to the War Department for its work and to the Treasury Department for its expenditures. Our light-houses are designed and constructed by military engineers who report to a mixed board of military officers, naval officers and civilians, under the direction of the Treasury Department. The personnel of these boards and the assignment of officers in charge of the various projects are so often changed that it is unusual for a piece of work to be completed under the direction of the engineer who planned it. Consequently there is generally such a division of responsibility that when a failure occurs there is a clear case of no one to blame. It is evident, therefore, that any plan of reorganization, the ultimate object of which is not to simplify, unify and systematize these complex elements, will fail to accomplish the good intended.

The most sanguine reformer cannot expect, of course, to change the present state of chaos to one of system and efficiency at once by simple legislation. The reform must to a certain extent be gradual, and while it would not be good policy at the outset to incorporate all the public works of the country into one department

under an entirely new administration, the plan of reorganization must be such that they may be added to the system whenever desirable, without necessitating any material change in the working of the department. This being the case, the initial organization must be of the same general form as that required when the entire public works of the country shall be comprised in the department. *Any plan to be effective must reduce governmental interference in the administration of its affairs to a minimum, and completely eliminate all political influence.*

In order that the maximum efficiency may be attained and maintained in the department, promotion must depend on the principle of "the survival of the fittest," instead of that of military succession. The economical disbursement of funds and the obtainment of the best practical results at the least expense should be the controlling factors in both the designs and the management of all important public improvements. The outline of a scheme of reorganization which follows is suggested as fitted when fully established to produce these conditions.

The object of the plan is to systematize and finally incorporate under a Department of Engineering all public works of a national character, the Chief Engineer to be known as the Secretary of the Department. The plan of the department would embrace five divisions, each under the direction of a Chief of Division, and to be designated respectively :

I. Division of Finance.
II. Division of Surveys and Examinations.
III. Division of Rivers and Canals.
IV. Division of Harbors and Docks.
V. Division of Light-Houses, Locks, Dams and Public Buildings.

The Chief Engineer of the Department, together with the four division engineers, shall constitute a permanent board of review for all questions that may arise in the department, or may be submitted to it by Congress or the general Government. Under each division engineer, there shall be as many resident engineers as may be necessary to personally supervise and direct all important examinations and improvements carried on in the respective divisions. Such number of assistant engineers will be appointed as the resident engineers may need to successfully prosecute the works under their direction. It shall be the duty of the resident engineers to investigate fully all new projects in their districts before submitting plans and estimates for the improvement,

and in every case the data on which plans are based should be fully set forth in a report to the chief of the division. All reports shall be open for public examination as soon as transmitted to the Department, and in the case of surveys and examinations of works under contract the results shall be promptly furnished to the contractor whenever required.

In all cases where the board of review cannot *fully* endorse the plans of the resident engineer for any important public improvement or whenever competing civil engineers and contractors submit plans differing from those of the department engineers, it shall be the duty of the Chief Engineer to convene a board of expert civil engineers to fully investigate the projects submitted, to modify the plans of the Department engineers when found defective, and to decide on the relative merits of the competitive plans laid before them.

The plans for any given improvement having been adopted, it shall be the duty of the resident engineer to prepare specifications for the same and advertise for proposals for material and labor for doing the work. On works where the object of the improvement is to obtain certain results, such as the improvement of waterways and harbors, the contractor may submit a bid in accordance with the plans and specifications of the Department engineers, or he may submit a bid for doing the work on plans of his own, but in the latter case he must become responsible for obtaining such permanent results as may be required, and in case of failure forfeit all claim for compensation.

In no case shall bids be accepted when materially in excess of the estimates of the resident engineer, unless in the opinion of the board of review such estimates are too small. In all cases where bids are excessive, they shall be rejected and the work conducted under the direction of the resident engineer, and if the cost of the completed work shall finally be found to greatly exceed the estimates, such results are to be duly considered in reference to the engineer's promotion in the Department, while if his plans prove a failure his resignation should be in order.

In these days of trusts and combines it is not safe to make an arbitrary rule that all work must be let to the lowest bidder, and consequently the Department must be prepared to execute its own work when bids are excessive, and at the same time be able to do it as cheaply as it could be done under contract.

It shall be the duty of the Finance Division of the Department

to audit all accounts and to make and carry out such rules and regulations for the disbursements of funds that the engineers of the different divisions may devote their entire time to the consideration and direction of the works under their charge. All officers of the Department should be retired at the age of sixty-four, unless on account of their eminent services Congress should deem it for the best interests of the country to retain them longer.

The central idea of the organization should be *to secure to the public service the constant and effective influence of competition with the foremost engineers in private practice:* to the end, not only that our public works shall reflect the best practice of our times, but especially that eminent civil engineers may *always be assured of the opportunity* to execute such great works as Captain Eads accomplished at the mouth of the Mississippi, after the failure of the Government Engineers, and in spite of apparently insurmountable obstacles.

The Department may be established primarily in the following manner: The President of the United States shall appoint a board of five eminent civil engineers, none of whom are in the Government service, and preferably the presidents of the principal engineering societies of the country, whose duty it shall be to investigate the professional records of the military and civil engineers of the present Corps, and of such civil engineers as may be candidates for appointment to the positions of Chief Engineer, division engineers and resident engineers of the new Department, and nominate one Chief Engineer, four division engineers, one chief of finance, and such number of resident engineers as may be required to direct the works of the different divisions of the Department, due regard being had to the special qualifications of each for doing the work of the division for which nominated.

Each nomination shall be accompanied by a brief statement of reasons and references on which such nomination is based. If these nominations are satisfactory to the executive department of the Government, the President, with the consent of the Senate, shall appoint these nominees to the positions respectively designated in the report of the board. The Department being organized under the officers thus appointed, the necessary assistant engineers required should be appointed by the respective resident engineers by competitive examinations, due regard being given to practical knowledge and experience as well as theoretical knowledge of the work required. The engineers shall not be transferred from one

division to another unless the chiefs of these divisions consider such change for the best interest of the service.

Any temporary vacancy in the office of Chief Engineer shall be filled by the senior division engineer as acting chief. Temporary vacancies in the offices of division engineers to be filled by the appointment of a resident engineer of the same division, by the Chief Engineer. Temporary vacancies in the offices of resident engineers to be filled by the respective chiefs of divisions by appointment from the ranks of assistant engineers. These appointments in no manner to be considered as giving the appointees any right to expect permanent election to such offices.

For permanent promotions and elections the Chief Engineer shall each year, or oftener if necessary, appoint a board of three eminent civil engineers, not in the service, and preferably the presidents of the most prominent engineering societies of the country, whose duty it shall be to consider the qualifications of candidates for appointment and promotion, and nominate two candidates for each vacancy to be filled, each nomination to be accompanied by a brief statement of the reasons on which such nomination is based.

In no case will it be allowable for candidates or their friends to use personal influence with the board to secure nomination, but they or their friends may make a brief synopsis of their professional record with references to reports and original investigations and submit with the application. These nominations, having been duly considered by the board of review, shall be submitted to the resident engineers for ballot, such ballot being secret and of some such character as that in use by the American Society of Civil Engineers for election of members. If the board of review shall consider any of the nominations objectionable, they may state reasons and ask the board to reconsider their recommendations. If an agreement cannot then be arrived at, a third nominee may be added to list to be voted for. The candidates receiving the greatest number of votes shall be considered elected.

Any civil engineer qualified for the position, whether a graduate of West Point or of technical schools, may be a candidate for any office in the Department except that of Chief Engineer, for which office the nominations should be made from the division engineers.

In all cases where the qualifications of candidates are apparently equal, the preference should be given by the nominating board to engineers in the service. All nominations of engineers not in the service for positions in the Department must be from engineers

eminent in those branches of the profession belonging to the divisions in which the appointments are to be made. Under such a system of nomination and election as the above, incapacity would prevent nomination, and discourteous and unprofessional conduct would prevent promotion or election.

Original investigations shall be encouraged on the part of resident and assistant engineers, who may report the same directly to the chief of the division, and if found worthy will be published by the Department annually for the information of the profession. Such investigations and reports will be duly considered by the nominating board in making recommendations for promotions.

The works under the direction of the resident engineers would probably have to be classified according to their importance, and the pay of the engineer in charge regulated by the character of work assigned to him. Promotion from one class to another could be regulated by the same rules used for promotions between grades. All allowances for expenses should be based on actual expenditures, and all perquisites, such as milage, etc., strictly prohibited.

The salaries to be paid the officers of the different grades should be made a matter of careful study, and so established that the best talent of the country may be secured for the service. The Government is amply able to pay as much as private corporations for first-class service, yet it is a notable fact that under existing arrangements the compensation offered is no inducement to experts in the profession, and at the same time is a very high price for the character of service secured.

In the primary organization of such a body, if it is not deemed advisable to make it a full Government department from the first, the only change required would be to have the Chief Engineer report to the secretary of one of the present departments, preferably the Treasury, in order that all accounts may be audited in the department under which the work is done.

NOTE.—The department of "Comment and Criticism" this month contains several communications bearing upon the subject discussed by Mr. Wisner.—EDITOR.

EVILS OF MUNICIPAL GOVERNMENT.

By William Nelson Black.

THAT there is a close resemblance between some of the features of municipal government, so called, and those industrial combinations that call for the services of the civil engineer will be readily conceded. Hailing under different appellations according to the taste of the framers of municipal charters, every city is provided with its public-works department; and an official engineer is thought to be as legitimate a public functionary as an official chief of police or an official corporation counsel.

Two chief causes have combined to produce this resemblance, a resemblance exceedingly anomalous under our American theories of democratic public administration. In the first place the municipality was never meant originally to be a government. It was an offshoot of feudalism conceived for the purpose of holding in leashes the population of those growing industrial centers that were becoming troublesome if not inimical to the Crown; and it simply provided the machinery through which weavers, shoemakers, blacksmiths, butchers, and such like uncongenial persons, could be reached more directly and systematically than through their baronial chiefs. But there was no intention of conferring on these commonalities, as the new political bodies were contemptuously called, any truly governing functions. The Crown sought to give the show of independent authority and responsibility without its substance, and, with this object in view, it was only natural that it should find in a resort to such manual labor as the limited civilization of the period could turn to public account an expedient for distracting the attention of the populace. The idea, therefore, that the new political organizations should be set to grading the king's highways was a conception entirely consistent with the ratiocinations of the king.

But this was not the only and possibly not the chief reason why these bodies were early endowed with industrial functions. At the period when municipalities were first constituted there was no form of social organization prevailing except the political form, and there were no other means so available as political means for the execution of what we have learned to call public works. The

guilds may be traced back to a very early period; but these associations were in no operative respect industrial organizations. That form of social organization which we have learned to call economic in these days of highly organized and aggressive industry, and which has already proved itself to be the most potent form ever conceived or conceivable, was altogether unknown in feudal times, and men were compelled to depend upon political machinery for the execution of everything beyond the resources of individuals. This is probably the chief reason why the engineer became and still remains an important top feather in the head of the municipal goose. Social habits and routine are the most obstructive forces that the world is compelled to meet and master; and it is because of their potency that Liverpool still owns her docks and warehouses, Philadelphia her gas works, and New York a variety of objects to be considered in the context.

But is it wise or expedient to put any kind of productive work in the hands of municipalities? This is a question of some moment to day, and before attempting to answer it let us clearly understand the nature of these bodies. They have never contributed anything to the liberties of the individual. It may be said, also, that unless he was either an official, or some person leagued with officials for the purpose of reciprocal gain, they have never added anything to his emoluments. They were originally the engines of strong government seeking to perpetuate itself by the use of machinery called constitutional, but really centralizing and despotic. Even their industrial features were conceived for no better purpose than to strengthen the hand of the political master by increasing the resources of patronage. It would not, therefore, seem to be either wise or expedient to trust them too confidently. But there is an old and familiar adage which says that politics makes strange bedfellows, and we have been supplied in recent years with some striking evidence of its truth, for, notwithstanding the offensive origin of the municipality and its manifestly sinister influence on democratic constitutions, we have managed to raise quite a crop of incipient imperialists, not yet in head, who in the name of popular liberty would give to the dangerous agent more power for the promotion of despotic and plundering schemes than even its original creators were able to confer. These novices in political science would seize upon all our most available industries and place them in the hands of political rings. But will it be worth while to waste time in finding arguments to prove that municipalities ought not to

engage in productive work? All the facts to be gleaned from either history or current experience only serve to show that such bodies ought to be abolished altogether, and their functions turned over to economic agencies.

Does this proposition sound startling, extreme, revolutionary, or sensational? Let us see if it be not really conservative and logically democratic. It will be very easy to show that the municipality is unnecessary, and if it is further seen that it is industrially inefficient and politically corrupt any plea for its perpetuity would be idle.

Take the city of New York, the chief city of the country, as an illustration. She owns her water-works and market buildings. She owns, also, all that has not been alienated of the submerged lands around Manhattan Island on which are located the piers, and she holds a joint interest in the New York and Brooklyn Bridge. These are all productive works of a kind that, in many other cities, are owned and controlled by economic agencies. She has also a department of public schools—rather State than municipal institutions, however—and as these schools are conducted in competition with numerous private schools and colleges they manifestly belong in the category of productive interests. But in addition to these interests, which will be conceded to be productive without any modification of prevailing industrial and financial customs, New York, in common with all other cities, paves her streets, builds her bridges and sewers, and performs other labor that could easily be turned into economic channels and made to pay well in dividends.

This is the material situation in New York. There is also a moral situation which might be depicted were it necessary to the argument. A clergyman of distinguished position and eminence, the Rev. Dr. Parkhurst, thinks the city fit only for one of the dwelling-places of the lost, while a highly respectable daily journal, the *Sun*, a journal which places at the head of its columns a statement that compels it to prevaricate twice when it only wishes to prevaricate once, declares in substance that she is ruled only by angels of light. On the moral condition of the city municipally considered, therefore, it will be seen that opinions differ. We only know that some of her most eminent official citizens have been sent to States Prison, and believe that were it necessary for the argument a considerable case might be made out in favor of the devil and Dr. Parkhurst. But it is not necessary. It is the purpose here to deal only with the material aspect of things, however

much the case might be strengthened by an appeal to moral considerations. It will be enough to inquire what service the "Commonality" of New York renders the public which would not be better rendered were all the various interests in the possession of the said Commonality managed by economic agencies.

Observe first, the performances of the city along the water-front. It is there that the influences of her hand have been most mischievously felt, and it will be there that we can study to best advantage the colossal blunder of permitting municipal intrusion in productive fields. The water-front of New York furnishes a disgraceful spectacle for a city claiming and elsewhere displaying a high degree of civilization. The land is almost valueless; the buildings are either mere sheds or the half-abandoned ruins of structures once hopefully erected, but now either converted into depots for the odds and ends of traffic or surrendered up to the keepers of third-class saloons, cheap tobacco stores or filthy hash-houses. Meanwhile the shipping of the port is being driven by fleets across the North and East rivers to find localities where economic agencies prevail. During all the years that New York has held possession of the submerged lands along the water-front she has done absolutely nothing for herself except to poison the commercial fountain of her prosperity. But she has done wonders for Brooklyn, a city that has thus far escaped the grasp of an official water-front monopoly, and she is giving to the free people of New Jersey a larger commerce than they are able to handle with their obstructed riparian resources. Thirty years more of municipal manipulation along the water-front and New York will be as completely stranded commercially as a high-water wreck at low-tide.

But when we leave the water-front and go elsewhere to investigate we find little that is more encouraging to the advocates of municipal industry. Let us take a look at the great suspension bridge. This is the plum of two cities, not particularly nutritious to either city, but thought to be quite palatable to a few men who have no relish for anything better. We will not cross the bridge. If we cross it we will have to pay the highest fare charged for the distance anywhere in the metropolitan district; and as Poor Richard said, a penny saved is a penny earned. We will simply stand at some point of vantage, say in THE ENGINEERING MAGAZINE office, up in the *World* building, and just look at the structure. What do we see? An occasional train of cable railway cars goes

creeping across at long intervals. But what should we see? We should see elevated railway trains go dashing to and fro every thirty seconds, and this is precisely what we would long since have seen were the bridge managed by economic agencies. It is said that the structure is not strong enough for this service. But the piers are strong enough to sustain all the battle-ships of the British Navy were they cantilevered from shore to shore; and how long would the aspersion of structural weakness be likely to last were the bridge in the hands of men who would find it for their profit to develop its highest capabilities? A new company has recently engineered the passage of a bill through the Legislature authorizing the construction of a new bridge between the two cities. The directors would be acting more sensibly were they engaged in negotiations for buying the old bridge. A new bridge in a second-rate location could not be made profitable in twenty years; but even at cost price the old bridge could be made profitable as soon as it could be prepared for heavy service, and its supernumerary force of policemen, gripmen and higher up top feathers pruned away.

This much for the water-front and the bridge, and now the less said about the much-vaunted water-works of New York the better. Some men think them admirable because they never had an experience of anything superior; but after all the money that has been expended on those works when we see men on the third floors of buildings in some of the lowest sections of the city forcing water into storage tanks through hand-pumps, we cannot help wondering how long an economic company would be permitted to compel such uncompensated labor. The water brought, too, through the new conduit is notoriously filthy. For the money expended economic agents would have given to the people of New York the pure water of Lake Champlain, or of Lake Ontario.

As to the market houses, the more intelligent of the city officials are themselves ready to confess that, in private hands, with such buildings as individual enterprise would find it profitable to construct, they would pay a larger revenue, even to the city, than is now collected in rents.

Now, let us consider, in few words, the subject of public schools. Here the reader may possibly think in advance that the discussion must be pursued in somewhat begging or equivocal terms. But it will be pursued in no such terms. In the first place the public schools, as already suggested, are not municipal but State institu-

tions ; and in the second place the very idea of a free school is very much like a Will-o'-the-wisp. Men who think that anything can be free, except to paupers, have little conception of the power of taxes to distribute themselves through rents and prices of all kinds. Each head of a family pays for the tuition of his children, and under the so-called free-school system he pays fully as much by the end of a year as he would pay if he discharged his obligations directly to the tutor. Even were the public schools a municipal institution they would not be a buttress for the municipality. Were the schools of New York conducted by economic agencies, the children of the city would not be less well instructed than they are at present.

Come, now, to the consideration of the public-works department in its labors of grading and paving streets and the building of bridges and sewers. It has already been considered in its achievements at supplying water, and the opinion was held, it will be remembered, that its excellence in that labor was not proved. Is it any more successful at street paving? This is a work which is usually thought to have no economic significance. But this impression has only served to perpetuate an abuse. Street paving and the building of bridges and sewers could be given a very great economic significance by a system of charges against property not differing in principle from prevailing methods, and it only concerns the people of large towns to know if it would not be best done by economic hands. Under the stimulus of strong prodding, almost frantic in its urgency, the public-works department of New York has recently made a considerable improvement on some of the chief streets, on streets, that is to say, that fall under the daily inspection of the class of citizens given to disturbing the municipal slumbers when anything goes flagrantly wrong ; but elsewhere the public thoroughfares are wretchedly paved. It is reasonable to presume that were it the universal practice to give the paving of our streets to operative companies, invention would long since have given us pavements incomparably superior to the pavements now in use, and that through the influence of competition they would be furnished at a much lower cost.

Similar reflections might be made with reference to street cleaning in New York. It is confessedly such an inefficient service that the streets in many parts of the city are disgustingly filthy despite the efforts not only of the street cleaning commissioner himself but of an occasional broom brigade of feminine volunteers, ladies from

on high who have fancied that the streets were filthy because men were unable to see filth. Wherever the streets are kept really clean the final work must be done by the householders. Yet in street cleaning we have a work that could be made economically profitable, and in economic hands the service would be unexceptionably rendered.

Let us dismiss the industrial features of municipalities then as something altogether beneath the conditions, resources, and demands of modern civilization, and study those strictly governmental functions which they have been permitted to exercise, under subject conditions, by both the Crown and the State. Their police and judicial duties are thought to be vital, and here possibly again the reader will imagine that the argument has met an obstruction before which it must completely break down. But the writer does not think the obstruction formidable. On the contrary, he will not even admit that an obstruction has been met. We have had for many years in this country a quiet body of men known as the Pinkerton detectives, and they have demonstrated that an economic police system is not only feasible but that it could easily be made much more efficient and reliable than the political system. Then why should it not be adopted in our large centers of population? There can be no question but that if Inspector Byrnes, for example, a good officer by all accounts, had authority to reorganize the police force of New York on an economic foundation, and, retaining only the competent and trustworthy members, to discharge the worthless and unprincipled, we should find a greatly improved service. Such a force would be amenable to the law and not above it. The members would be the servants of the people, not their masters, and the directing agency would be subject to penalties for any dereliction in duty. Why, even despite the vaunted police system of New York, it is probable that the number of private watchmen in the city whom individuals think it imperatively necessary to maintain far outnumber the political force, and the town is full of independent agencies for the public protection, or for private protection, which amounts to the same thing. The march of civilization and its needs has made it impossible to erect the political police system as a bulwark for the municipality.

As to the courts there is no good reason why they should be organized differently in different districts whether densely or sparsely populated. The crimes of the countryman are as heinous as the crimes of the townsman, and territorial considerations could have little influence on the decisions of judges.

These are a few of the arguments that may be brought against the municipality not merely when it is a question of its intrusion in the field of industrial production, but when it is a question of its participation in any field, or of its right to an independent being. It is a medieval survival maintained apparently for no purpose in these enlightened days except to perpetuate the undemocratic rule of taxation when men should be taught to meet all their domestic and social expenses by the payment of bills.

It is time in this country to recapitulate and sum up in the argument for democracy. We have yet a much too large survival of despotic traditions. We have also an incredibly large number of men, not of the most intelligent, but who hold themselves for profound thinkers, who seem to have lost all sense of distinction between the terms government and people. These men continually think that they are advocating the cause of the people when they are calling frantically for new shackles and more government ; and the first bauble that should be put beyond their reach is the municipality. It is the most undemocratic thing in America. In fact it has no place in the economy of the American Constitution, but effected an entrance into the country through the back passage of pre-revolutionary facts. It is not a government and it cannot be made a government without the institution of that chief of absurdities known as an *Imperium in imperio.* There can be no parallel between the relations of the State to the Federal Government and the relations of the municipality to the State. It would turn the State into a bedlam of conflicting regulations to attempt to establish such relations. It is made almost a bedlam already by the lack of symmetry and consistency between country and town. The municipality is simply an ugly excrescence on our constitutional system which the founders of the republic found growing and forgot to prune away. It should be the first to fall in the conflict now on between political and economic organization.

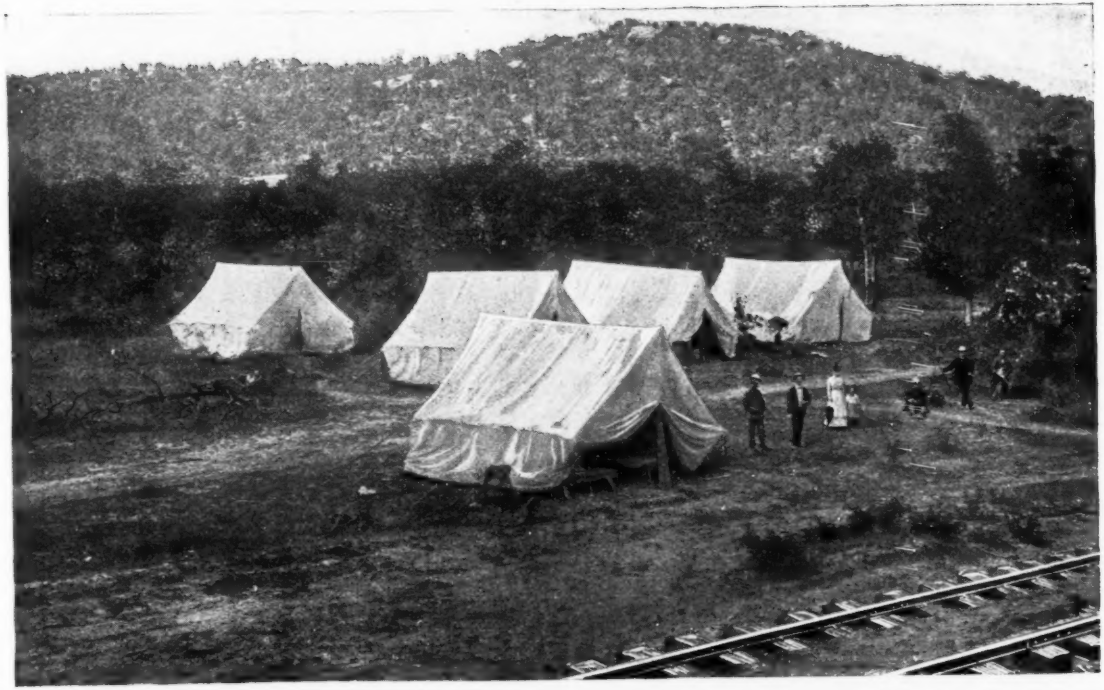
BUILDING A RAILROAD IN THE SOUTHWEST.

By James S. Coleman, C. E.

THE building of railroads, by which is meant the actual work of construction, before the period of operating them begins, is an important business of itself. The extent to which it has been developed in this country may be inferred from a glance at the record of the growth of the railroad system. In 1850 only 9021 miles of railroads existed here; in 1860 the mileage had increased to 30,635; in 1870, notwithstanding four years of civil war had intervened, there were 52,914 miles, and in 1880 there were 93,000. During the next ten years came the period of the greatest railroad development, particularly over the long distance lines of the Great West, which has brought the total—including side-tracks and switches—to more than 200,000 miles of track in actual use. One result of this period of enormous growth was to reduce to a system the work of construction and the equipment of "outfits" for the work. By the way, the figures quoted here make a remarkable showing, but as the roads were built for the most part by private capital, presumably on a paying basis, it is evident that the construction on the whole has only kept pace with the requirements of the growth of the country in wealth and population.

It will not be out of place here to mention that railroad companies after having obtained a charter to build a proposed line, make surveys of the routes suggested, to ascertain the most desirable location. Frequently several preliminary surveys are made before the location of the line is determined. The cost, distance and grade are the determining features of the preliminary surveys. When the line has been adopted by the company, or board of directors, its province substantially ceases for the time and the work of construction commences. The chief engineer then becomes the great arbiter. Under his direction the specifications are drawn, the contracts made and the road built. It is intended in the present paper to give some notes on the track-laying on the Texas & Pacific Railway, starting at Fort Worth, in 1880, with which work the writer was connected.

Owing to the extent of territory to be traversed the work of construction on the earlier western lines was generally remarkable



CAMP NEAR CLAYTON MOUNTAIN—HEADQUARTERS TEXAS & PACIFIC RAILWAY, 1880.

for speed, much anxiety being felt to reach a given point at an early date to prevent the extension of rival lines. The making of the road-bed, or "grading," over rolling prairie country is not usually very difficult work, as the maximum grade of the roads west of the Mississippi is not generally kept below 52.8 feet to the mile. This allows the engineer to make a comparatively straight line with light grading, since the roll of the prairie rarely exceeds the established grade. But on some of the divisions of all the great lines deep cañons and rough ground near the "divides" are found, when it becomes necessary to build high trestles, or make deep cuts, as the conditions may require. To overcome these difficulties and prevent the detention to track-laying special contracts are executed, providing for the completion of such heavy work in advance of the requirements of the track-laying outfit.

The grading of a road-bed is done more cheaply on the frontier, but not so systematically as in the Eastern States. The graders' outfit consists principally of mule teams and road-scrapers. The "fills"—in depressions below the established grade—are made by scooping in from the sides of the line any material convenient and suitable. There is none to question or dispute the size or the bounds of the "borrow" pit. The "cuts"—through elevations above the established grade—are wasted out on the banks, the engineer in charge only requiring that the material shall be removed sufficiently to prevent its being washed back by the heavy rains peculiar to that climate. The timber for trestles and other heavy bridge-work is prepared ready to be set in place, from the plans given by the engineer, at the place from which the road starts, or other locality where the required material is available, which not infrequently is at a considerable distance from the location of the bridge. As the track-laying force approaches the chasm or stream to be bridged the timber is shipped to the end of the track, whence it is hauled by team to the place where required, when a competent force of mechanics speedily fits it in position. In this way trestles of several hundred feet in length and fifty feet in height are sometimes constructed in three or four days.

The prompt furnishing of supplies of material is one of the absolute requirements of rapid track-laying. The material must be at the front when needed, in sufficient and proportionate quantities. Otherwise the force comes to a "stand-still," which is as demoralizing to the men as it as annoying and detrimental to the interests of the contractor. When the work of track-laying was started on

RED BLUFF CUT, BRAZOS RIVER (103 FEET DEEP).

the Texas & Pacific at Fort Worth, it was the understanding that material should be furnished as rapidly as the force could lay it. As our contract comprised all the bridge-masonry, track-laying and telegraph work, we organized at once for the Brazos River bridge. The piers and the abutments were quite heavy, but an excellent quarry of limestone, found on the banks of the river and near the location of the bridge, greatly lessened the difficulties of the work. A force consisting of quarrymen, stone-cutters and masons, with their outfit of teams and wagons loaded with derricks, tools, camps, etc., and an additional train of wagons loaded with cement, was started from Fort Worth, in charge of a superintendent, with directions to have the structure completed in time to prevent any delay to the track-laying force, which was then being organized to extend the line of the road as rapidly as possible, it being our desire to complete the road to El Paso, distant more than 600 miles from Fort Worth, by January, 1882. The masonry work was finished in time. When the track-laying force reached the Brazos the masonry work had been completed and the temporary trestle or "false-rock" was ready for the track which was laid. The first train crossed the Brazos River on the same day the bridge was completed, and without delay to the track force.

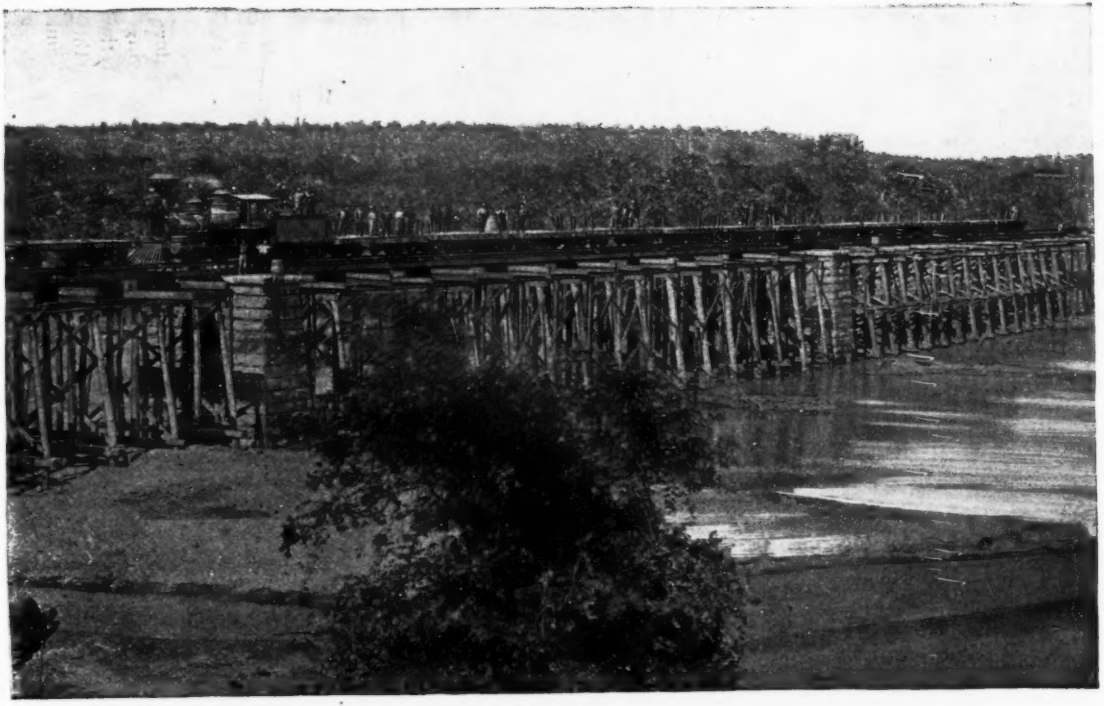
After crossing the Brazos the track-laying force, which to this time had been maintained at a one-mile per day standard, was increased to a mile-and-a-half standard, in order that the work might be pushed more rapidly ; but numerous and frequent were the detentions to the force occasioned by the inability of the company to furnish the iron and the ties as fast as they had anticipated. One week the mills in Pennsylvania were to be blamed ; the next, transportation between the mills and Texas was irregular and at fault. I was determined, however, that we should understand each other, and that if the company could not furnish the material as it had agreed I would reduce the force to meet the requirements of the case. Shortly after this a better understanding was arrived at. Major Washburn, the Chief Engineer, a very energetic and capable man, recognized the necessity of furnishing the contractor material instead of excuses if the track was to be completed by January, 1882. We met near the Brazos as I was on my way to Fort Worth to arrive at some definite understanding in the matter. We dismounted and seated ourselves on a petrified log that to all appearances had lain there ever since Adam lived in the garden of Eden, and of which I still have a piece. The Major gave me

LOOKING WEST FROM TRAIN CAMP, GRAND RANCH.—TWO MILES OF TRACK LAID ON PREVIOUS DAY.

every assurance that the material would be furnished in future not only in quantities sufficient to keep the force constantly employed but to warrant a further increase, as the company was exceedingly anxious to reach El Paso early in the autumn of the next year.

But notwithstanding this definite agreement the delays were still frequent and annoying, though I believe that the Major tried to the best of his ability to fulfill the company's part of the agreement. Beside the detentions caused by lack of material, much time was wasted by delays occasioned by the lack of necessary motive power to handle the material at the front as required. That the Major failed to keep his part of the agreement was, I believe, no fault of his, but due rather to the disadvantages under which he labored. I make this statement in explanation of what Mr. George W. Rafter said in his interesting article in the October (1891) number of THE ENGINEERING MAGAZINE. He wrote: "Somewhat better average results have been obtained on other work, but for rapid track-laying under all sorts of disadvantages, this record of the Texas & Pacific extension stands unique. The rate of two miles for every working day was maintained for several months."

In the construction of railroads the track is usually accepted by the railway company as the work progresses in sections of a given number of miles. The material used is furnished to the contractor at some point along the line, called the "delivery point," which usually is at the end of the last section of the accepted track. At this point the material trains are made up at night for the following day's work. The cars loaded with iron are placed in front of the locomotive, to be unloaded as near as possible to the end of track, while the cars with ties are placed in the rear. The material is carried by the material train to the end of the track and unloaded in a convenient place for handling, as near as possible to the working forces. In the arrangement of the forces for the actual work of track-laying the "tie-squad" is in advance of all others. The ties are loaded upon wagons and hauled along the grade ahead of the line of track, where they are unloaded on the road-bed, and spaced and set to a line given by the engineer, who always accompanies the force at the front with a transit during the hours of track-laying. When doing the most rapid work, which was in the valleys of the Pecos and the Rio Grande, a force of 125 men were engaged in this branch of the work. Close in the rear of the tie "setters" and "spacers," follow the "iron-squad"—a set of strong and robust men who are very expert in their work. This force and the



FIRST TRAIN OVER BRAZOS RIVER BRIDGE—TEMPORARY TRESTLE.

"spikers" that immediately follow them are important factors in track-laying.

To lay one mile of track per day a single iron truck is sufficient but if two or more miles are required a double squad with two iron trucks should be used. The iron truck is loaded where the rails were dumped by the material train, and drawn usually by a "snap-horse" to the end of the last rail of track, when the men, divided into two side gangs, run two rails out over rollers secured in the end of the truck, dropping them in place on the ties. The ends are then brought "snug" with the rails already set and the rails placed to a proper gage. This is done quickly and the iron-truck advanced and two more rails similarly placed and the process repeated until the "iron-truck" is unloaded. It is then lifted from the track to make way for the second iron-squad which has loaded a second truck while the first truck load was being laid. The work was very hard for the men, but as much as three miles of track were thus laid in a single day, and two and one-half to two and three-quarters was not unfrequently a day's work. Closely following the iron-truck came the "strappers," who fastened the ends of the rails together with plates and bolts, and the first "spikers," who spiked only the joints and centers of the rails to the ties, which held them securely enough to pass the loaded iron-truck to the end of the track.

Following the tie and iron squads came the main force of "spikers." This force is kept at sufficient strength to keep the work of full-spiking near the front so that the material trains can deliver the ties and rails convenient to the working forces. The "lining," "surfacing," and "back-filling" is done by three separate squads of men in the order named. When these squads have finished their work the track is complete and ready for regular service. After inspection by the Chief Engineer it is turned over to the railway company and a permanent repair gang put in charge.

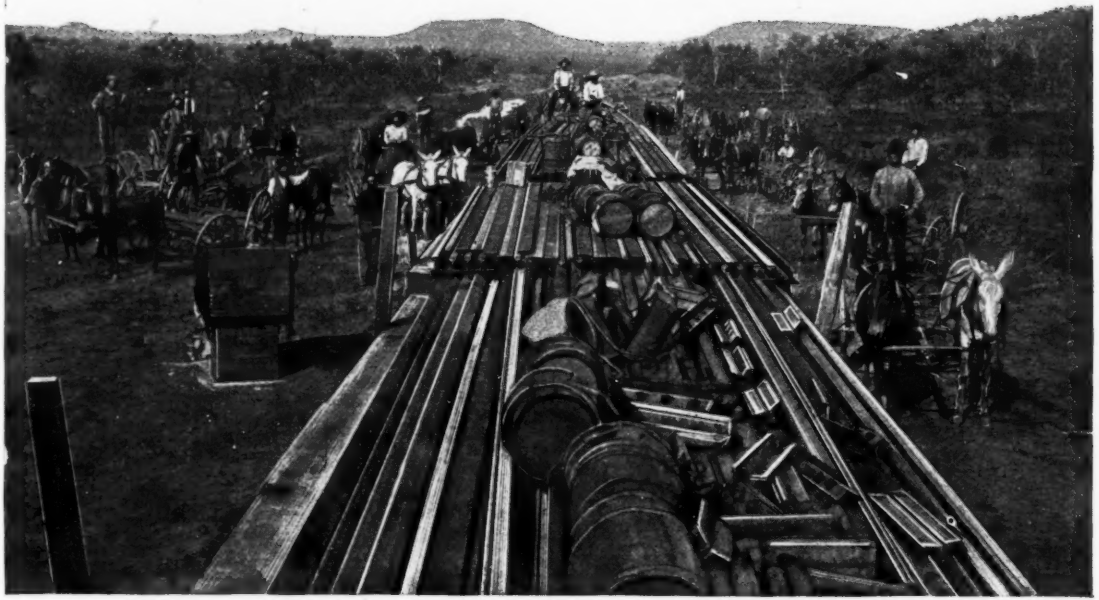
The climate of the plains was pleasant. During the summer months the weather was very hot in the day-time, but the nights were cool. There was always a refreshing breeze. I never enjoyed better health than while in camp on the plains. Some of the camp sites were very picturesque and many pleasant incidents occurred in connection with the construction of the work. We thought nothing of riding horseback fifty miles a day over rough new country attending to matters pertaining to the work. In fact my brother, M. S. Coleman, who started the work at Fort Worth, and remained with the outfit until it reached the Brazos, when he returned to New

IRON GANG, TEXAS & PACIFIC RAILWAY—CLAYTON MOUNTAIN.

York to build the Weehawken tunnel on the West Shore railroad, rode from Fort Worth to the Brazos and returned to Weatherford in one day—a distance of about a hundred miles.

I remember with pleasure an antelope hunt west of the Brazos. Having visited our camp near Grand Ranch, I was returning to the train camp, accompanied by some of the engineer corps, and the "boys" had their dogs along. Our party numbered four or five, and the dogs which accompanied us no less than a dozen. As we rode along the mixed-breeds would give chase to prairie dogs, jack rabbits and all sorts of small game, but the thoroughbred—a fine large hound—would raise his head in disdain and follow near his master, as if saying of his fellows: "They don't know what sport is; I will bide my time and not tire myself out before my services are required." It was about sunset and our destination was ten miles distant. The air was clear and bracing and the full moon had just risen. We were at a point on the line where the track was not over a foot or two above the prairie—such a place as antelopes are apt to cross in their grazing excursions, for they always avoid deep cuts and high embankments. In crossing they approach the track cautiously, but, like sheep, when the leader jumps over the others all follow. Thus it happened that we came suddenly upon a flock in the act of crossing. Jack, the big hound, sounded his note of appreciation and bounded away at full speed, the other dogs imitating his example, but with indifferent success. Such an opportunity for a chase of antelope over a wild country, after such a pack of well-meaning, although untrained dogs, was not to be missed. The rein was given to the horses, and we all started in hot pursuit, the exciting chase continuing without abatement of interest for seven miles. We enjoyed the sport thoroughly, though we did not succeed in capturing the game. Riding a swift and powerful horse I distanced my companions, and while waiting for them to come up, from the crest of a high roll in the prairie, I observed the lights of the train camp not more than four miles away, as the antelope had taken a course leading toward the camp. On the arrival of the party we thought it better to postpone our impromptu stag-hunt to another day.

Mr. Rafter in his article on "Railroad Building on the Frontier" speaks of the difficulty of procuring an adequate water-supply on the Texas & Pacific work, and modestly refers to the part he took in the company's endeavor to obtain that very important requisite for a construction outfit. The water-supply had been overlooked on

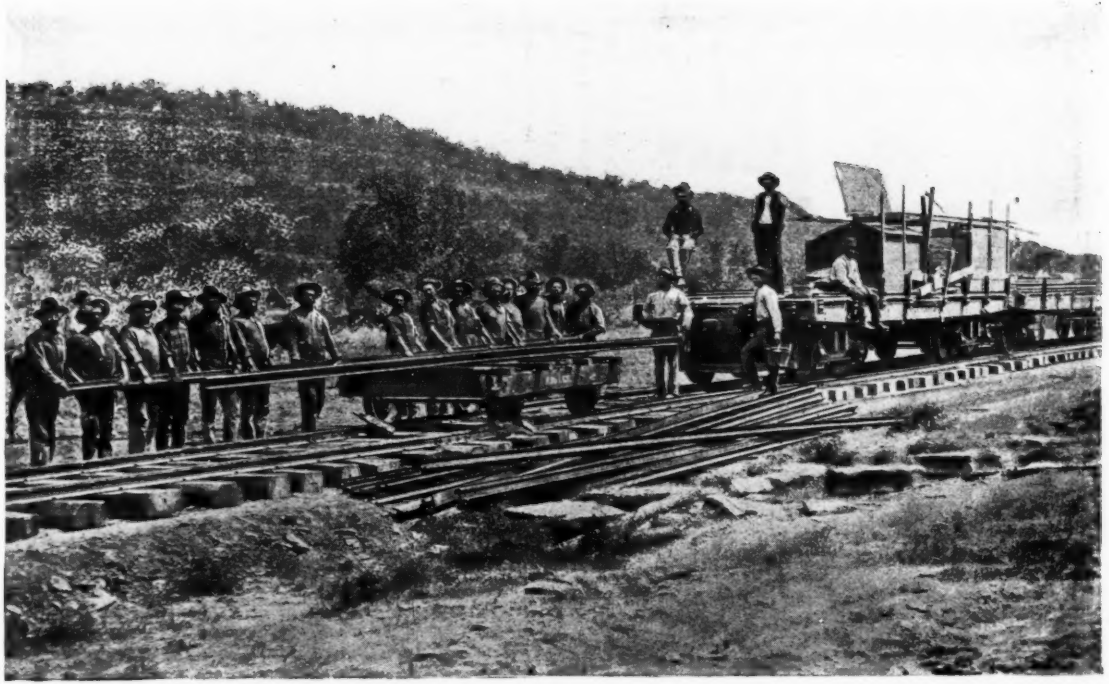


IRON TRAIN AND "TIE TEAMS"—CLAYTON MOUNTAIN IN THE DISTANCE.

the Texas & Pacific until Mr. Rafter was placed in charge of an outfit to locate and construct wells, in August, 1881. The track-laying force was then in the valley of the Pecos River, which was crossed on August 24. The inadequacy of the water-supply grew more serious every day after the outfit crossed the divide between Colorado River and the Pecos. An idea of our need at the time Mr. Rafter took charge may be obtained from an abstract taken from the minutes of the "track report," or daily note-book: "Bought tank of water to-day for engines; price $25." A tank of water purchased on the plains meant such muddy water as could be obtained from a pool that had been scooped out by a rancher to collect water for his cattle when rains occurred. These holes were the property of the rancher and as valuable to him as necessary to us. It was necessary at times to run water-trains a distance of more than 100 miles to secure the supply necessary for the engines, and for stock and camp uses. Sometimes telegrams came in like this: "Water-train not arrived; three 'dead' engines at front; had to draw fires."

Before reaching the Staked Plains in June, 1881, the stock force was considerably increased, as sand was found in some places so heavy that a team could only draw six or seven ties to the load, and, in order to push the track ahead as fast as the material was promised a larger force of teams was necessary. June 16, the date of our entrance upon the Staked Plains, was signalized by the laying of two and three-quarter miles of track—the best day's work done up to that time.

With the increase in the stock-force and the progress of the work westward the danger of a "stampede" became more apparent. The train was well supplied with Winchesters and other fire-arms from the start, but up to the time of our arrival at the Colorado River we had no occasion to take more than ordinary precautions to protect our property. We were warned by the action of the "gentry" who sometimes follow in the immediate wake of advancing civilization on the Western frontier that greater precaution should be taken. Additional guards by day and an armed patrol by night were therefore engaged, and to prevent a "stampede" of the stock at night the wagons were placed so as to form a circular enclosure, or corral, the wagons being locked together. In this enclosure the stock was placed and cared for, by the teamsters, under the protection of the armed patrol. The teamsters, whose tents were pitched near the corral, were armed with six-shooters



LOADING "IRON TRUCK."

and determined and ready for any emergency. The night guards never had occasion to alarm the camp, but I was assured afterwards that it was only by reason of the extra precaution taken that the "mule-stealers" had been kept away. On August 20, under an arrangement made by the Texas & Pacific Railway Company with the State officers, a company of Rangers arrived at our camp and remained with us until we reached the Rio Grande.

As before stated the greatest obstacle to rapid track-laying that we encountered was the delay in the transportation of supplies to the front. A force organized as ours was could easily lay from two and one-half to three miles per day with a proper supply of material on hand and adequate motive power to handle it. On October 14, on good ground, we laid more than two miles of track, although the force was actually engaged but six hours in track-laying. On October 24, with a pleasant day and fair ground to work over, a little over three miles of track were laid, though the teams were idle an hour and forty-five minutes and the "iron gang" delayed thirty-five minutes for want of material. This was the biggest day's work accomplished on the line, and so far as I have been able to ascertain, it is the longest piece of track ever laid from one end by a single force in a single day.

At this period of the work the railroad company probably were short of rolling-stock, for almost daily the ties were brought to the front in box-cars, which occasioned delay in unloading. The distance from the place where the ties were supplied in Eastern Texas was so great—nearly 800 miles—and the quantity of material so large that it was necessary to use everything on wheels that could be secured. On November 4 we laid the track through Carrizo Pass and arrived on the western slope of the Guadelupe range of mountains, or the valley of the Rio Grande. The grade was then more favorable, but we were never able again to reach the record of October 24. We advanced in the valley of the Rio Grande at the rate of one and one-half to two miles per day until connection was made with the Southern Pacific, on December 1, 1881, when the work of construction on the Texas & Pacific was finished.

HOW AN INVENTION IS MADE.

By Albert D. Pentz, M. Am. Soc. M. E.

GENIUS may be "the capacity for taking infinite pains," but ingenious mechanics do not accept this definition. A certain inventor said that if he were required to define genius he would call it "the education a man is born with," which may or may not be better than the definition first given. To me a mechanical genius is first a mechanical iconoclast, who does not hesitate to destroy an old device if it be wrong in principle or if it can be improved, and secondly, he is an ambitious discoverer who seeks mechanical truths, identifies them and places them where they give the best service. The accidental discovery of a new mechanical principle may not have required genius, but the judgment to apply it to the defect it is best adapted to overcome may exercise the highest endowment of genius.

Invention is an art, and it comes neither of a powerful or peculiar intellectual equipment, nor of the habit of industry, nor from the capacity for taking pains. Invention either consists in the finding, by stumbling over it, of a novel thing or method; or it is the recognition, as having value to the arts, of something previously considsidered to be useless, or it is a solution found by persistently attacking a problem from sides or points which previously had not received such attention. A mind of the producing variety, well versed in mechanics, having the desire for novelty and the ambition to excel, as well as the industry and the creative instinct to fill those desires, can always evolve a method of greater economy than that in present practice, or it can always produce a tool that is able to dispense with hand operation, cheapen the result and improve the quality of the product.

In the finding of new and improved solutions of difficult mechanical problems it generally is found best to ignore, except for comparison, the present means of accomplishing a given result. The solutions that evidence the most originality come from attacking such a problem exactly as if it were for the first time a subject of mechanical interest. This method concentrates the attention on the problem itself in the abstract, and should withdraw it from the direct contemplation of faulty ways of solving the problem. This

procedure does not require that a man shall forget what he already knows of a subject; but that such knowledge shall be no factor in the solution of a problem before it is applied and found good. An experienced inventor will thus be free to apply to a problem, first his mechanical experience and then all the originality his mind is capable of.

In mechanics that which is admired is likely to be imitated, and the mind, if it dwells on an admirable device that produces results similar to those sought, will in an effort to surpass these results always tend toward mechanical equivalents and varieties of that device, and ordinarily will search neither in general practice and experience nor in the special experiences and practices of other arts, nor in novelty, for the means it requires to do its task.

An inventor who becomes interested in a problem may apply first an obvious solution, and if he by comparison finds it to be old and bad, then the rule is to turn it diametrically about or proceed to the other side and see if it can be solved better from that point. Cyrus, having in hand the problem of entering Babylon, probably first tried the most obvious method of going through the walls by the gates, and found that they would not yield to any force he cared to exert. Then he tried to get over the top of the walls, but this was not a practical solution either. But when he found a way to go practically *under* the walls, and suddenly appeared with his army in the streets, he had solved the problem by attacking it from a new point. This is the inventor's method, and it is all there is to it.

This art of invention begins by using the analytical powers and ends by the application of every known or new solution of probable efficiency to each point of the problem from which the analysis discovers it possible to be solved. Analysis is as properly applied to the differing phases of a solution as to the soluble points in the problem itself, because a device may operate well where it would fail if slightly modified. Thus, an eye-pointed needle and a barb-pointed needle may each, in peculiar kinds of sewing machines, penetrate a fabric, and in returning carry a thread which it has caught on the other side of the fabric from a special device, but it will be found to be impossible for the eye-pointed needle to return with the thread if it be placed in a machine requiring a needle with a barbed point. In the invention of both those machines a needle solved the problem at this point, but it was a particular kind of needle, different in each case.

One inventor is greater than another: If he be the better mechanic and knows more methods and devices to apply to a problem to be solved, or is more skillful in their application, or both; if his powers of analysis are greater or if he can judge with greater accuracy and without experiment the more probable solutions; or if he can design the more original solutions, or modify the problem so that it can be practically solved and produce the desired results. Again, one inventor is inferior to another if he be a poorer tradesman and devotes his energies to the solution of problems for which there is no probable mercantile demand or prospective profit. Such a man, infatuated by the novelties and mechanical beauties of his useless creations, fritters away capabilities which should be employed in solving problems of real use.

A person skilled in the art of invention will apply his formula of analysis to every device that attracts his attention and speedily determine to his own satisfaction whether or not its problems have been solved in a satisfactory manner, and if not, whether a better solution will pay. This habit is analogous to that of the geometer, and in fact some inventors are very industrious students of that great science.

An inventor's knowledge of science and the arts may only be theoretical, or it may only be practical. It seldom is thorough in both respects. But if an inventor has neither a practical nor a theoretical general knowledge of the art he seeks to improve he will be apt to produce solutions that will not command respect. It is a fact, nevertheless, that startling discoveries have been made by tyros who occasionally have stumbled on the solutions of important problems without in reality understanding the problems at all. The practical man generally finds a solution of practical simplicity, while the wholly theoretical man finds an involved and ingenious but impractical one. Inventions fail from a number of causes. The solution may be new, but inferior to that in use. It may be new and right, but too expensive. It may be the best solution in part and the worst in part—a most common fault. It may be inoperative. It may be but an improved detail of another person's machine, and that other person will not pay for it, or it may be a device for which there is no practical demand.

The writer, who has had some experience in inventing mechanical devices, will attempt here to describe the object sought in a hypothetical problem, the processes of thought employed in dealing with it, and the results gained. This solution is intended to

be a practical one, but because it has not been reduced to practice it may not work without modification. It is believed to be novel, but its claims in that direction rest on observations in American practice. It may be taken, however, to be novel with but few doubts. In either case, of novelty or the lack of it, this device will serve as well as another to indicate the steps of progress between the point where a waste of time in an art has been observed and the production of a device to largely utilize that waste. This machine has been designed solely to illustrate this article, and the inventions in it are given to those whom they may benefit. It is not drawn to scale, and the details may be said to be indicated rather than designed. Yet it is believed to embody a valuable suggestion.

Drop-hammers are among the most valuable of machine-tools. They are used in forging-shops to strike into shape from steel by one blow the irregular parts of guns, pistols and all similar works. A die on the upper member is sunk to receive one side of a piece and a die in the under member is sunk to receive the other side. The weight of the ram on the upper die often is a ton, and it falls from a height of ten feet, striking a blow of many tons. In special cases this kind of hammer is made of tremendous power, as in the shaping of locomotive driving-wheels.

A person who witnesses the action of the ordinary pile-driver may get a crude idea of a drop-hammer. If, in the under side of the ram or "weight" of a pile-driver there should be cut a desired shape, and on the top of the pile being driven there should be placed a die having a shape to correspond with the upper one, then, if a piece of lead were laid on the die on the top of the pile, the blow from the ram would drive the soft metal into both the shape cut in the ram and that cut into the die on the top of the pile. This, roughly, is a drop-hammer and its operation.

Many other kinds of work are done on this plan—the embossing of metals, the striking of medals, the swaging of sheet metal to shape, etc.—and in all these there is the same waste of time which may be observed in the pile-driver. The ram must ascend before it can descend for a second blow and the time of the ascent is lost, for it is clear that in many kinds of drop-hammer work, like pile-driving and swaging, a continuous shower of blows would be of advantage. In other kinds of work there must be time to remove one piece and insert another. Hence the problem here is to eliminate this waste of time from the motions of the ram as far as practicable.

In analysis: The first necessary fact obtained toward a solu-

tion is that it cannot be done with one ram, because in all drop-hammers the weight is now taken up as expeditiously as possible, and the fall cannot be accelerated beyond that due to the force of gravity. The second fact is that there is about time for a second ram to fall while the first is in ascent, and these two facts are all the material help toward a solution that the study of any existing drop-hammer affords. But the conclusion is forced on the inventor that the invention will be the finding of a means to substitute successively one ram for another over the die.

Now the most obvious way to substitute one ram for another is to oscillate one aside and the other into place by two sets of guides on the same frame which is hinged to a vertical pivot. This looks very well until the power to quickly overcome the inertia of the weight is sought; for both rams must be moved aside at once, and the transference of the lifting device from one ram to another is considered; then this solution is laid aside for a time until others are examined.

Turning the problem over, the idea of reciprocating the lower die from under one ram to under another comes as the next suggestion. The rams could be arranged so that while one was ascending the other could fall. Could the dies be transferred so quickly as to make this arrangement profitable? No. Now put a set of dies under each ram. Then we have two separate drop-hammers, which any one can have, so that solution is of small value to the arts. But an invention has been made and that is the combining of one drop-hammer with another so that one ram must drop while one ascends. Hence if we can do no better we can thus couple two in series. Of course that would not help a pile-driver, but it might be of some benefit in forging-shop hammers.

Dismissing the two rams in series as practically being two drop-hammers, we return to the alternating of two rams to drop one after the other over the same point. Now, it is asked, in what other ways may a ram be removed from over a die, which ram has been elevated at a location aside from that vertically over the die and then returned to its position at the top of the guides? This question is one that is best answered by a short description of one way to do it. It is obvious that the die on the upper ram must come off because that ram should begin to take a side motion as soon as it has struck its blow, and the die would interfere with that and be injured itself as well. Now if this die be taken off and held over the lower die in a suitable guide, it is evident that the necessity to

guide the ram with precision has gone, as well as the necessity to keep one particular part to it upward. Hence a ball for a ram is at once suggested as good mechanics, for these reasons: It would impinge upon the die on one spot at one blow, on another the next, thus distributing the blows over its whole surface. It may be very simply guided, and most easily carried. Now how shall it be carried? An endless belt like the grain elevator suggests itself. The pile-driver is lifted by a rope and a drop-hammer is generally taken up by a strip of wood operated between rollers.

The ideas for the solution are thus all got together, but more remains to be done. In fact the ideas are but a small part of many inventions and this one of that class. But enough has been shown to indicate in a manner the art of invention and further technical details would tire and not further instruct.

Mechanical problems do not usually submit to so few applications of possible solutions as this one and if the whole route to success in even some of the simpler appearing problems were traced, the patience of the reader would rebel before it was fully analyzed and long before it was solved. Most inventors stop at a satisfactory solution when perhaps the next one would greatly surpass it. Thus an art grows step by step and thus one man is enabled to surpass the other until its problems are perfectly solved. Then a new art with new problems is evolved which supplants it.

First, all men went to the water to drink. Then one man invented a carrier and constructed it from a gourd in which one man could carry water for many. Another inventor made larger vessels from skins or wood and loaded a quantity of water on an ass or on an ox-cart so that it could be carried a long distance. This perfected the art of carrying water as a burden. Then a genius attacked the problem of getting water by digging a well near his dwelling to avoid carriage and evolved a new art. Another inventor found the well-sweep which is the germ of all pumps, and from these beginnings grew the whole of the science of Hydraulics.

The most infinitely painstaking of inventors are those who produce the least original devices. They are painstaking but they neither thoroughly analyze the problems they attack nor proceed to solve them in any order. Is not invention mechanical selection?

The machine in Figures 1 and 2 shows the complete drop-hammer which is invented by the process stated. The frame *A* is of cast iron, solid below the dies, but a shell about one inch thick in

other places. The link belts J, and J^1, are supported and carried on six sprocket wheels, three of which, G, H, and the companion of H, not seen, are alike, and held on the studs B, B, of which G, H, and another are not directly connected to each other, and they are flush with the belts, J, and J^1, across their inner faces so as to offer no obstruction to any object of a width equal to the distance from J, to J^1, passing between them. The sprocket wheel on the shaft E, is like G, and H, except only that it is secured

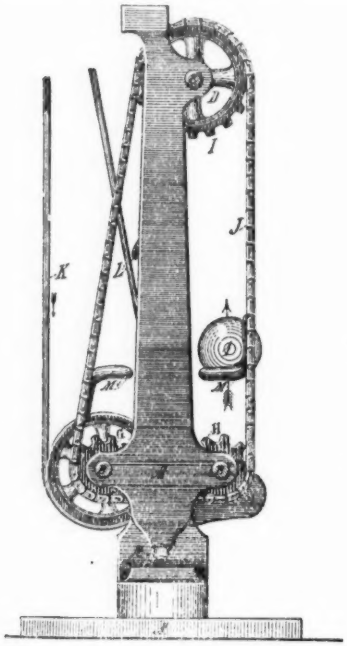


FIGURE 1.

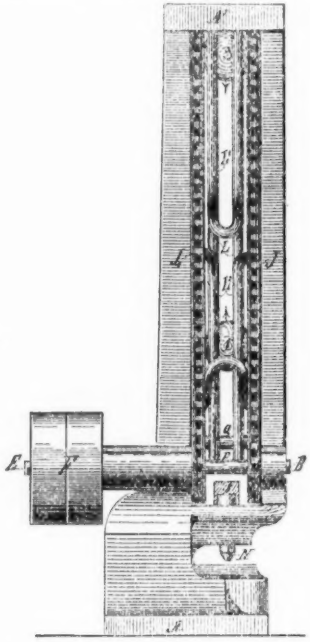


FIGURE 2.

to that shaft and turns with it. The fast and loose pulleys F, are attached to the shaft E, so that any motion which the belt K, communicates to the tight pulley F, is taken by the sprocket on the shaft E, and transferred to the belt J^1. On the shaft C, are secured the two sprocket wheels D, so that when the endless belt J^1, is moved, both these sprockets and the shaft move as well and transfer the motion of the belt J^1, to the other belt J, which in

turn operates the guide sprockets *G*, and *H*. Thus both these belts move equally fast and in the same direction.

At three points on these belts *J*, and J^1, and connecting them together are the chairs *M*, and M^1, and one not shown but in the figures it should be at the top passing the sprockets *D*. These chairs or carriers are loops of steel made and shaped as shown to catch and carry the balls 1 and 2 safely and certainly. The ball 1, in the chair *M*, shows how it is arranged, Figure 1.

The guides *L*, are smooth bars of steel which are fastened at the bottom in the bar *Q*, and from there ascend straight to the shaft *C*, which they embrace each by an eye. The guide L^1 is a staple-shaped bar attached to the header A^1, and extending about half way down, the lower end at the loop is turned outward as shown in Figure 1. The two guides L^2, are fixed at their lower ends to the bar *P*, and extend upward to nearly the position of the guide L^1, and then turn outward and are secured to the frame *A*. These guides thus make a pathway for the balls 1 and 2 to drop freely through but at the same time they permit the chairs *M*, and *M*, to pass outward so that while the balls 1 and 2 cannot escape neither can they strike these chairs in their descent.

The ball 2, in Figure 2, is starting to fall and it is presumed that the chair M^1, will be at sprocket *G*, when the ball 2 has reached its plunger *N*, and that this chair will have reached this plunger at the rebound if there be any. Then the chair, by embracing both sides under the ball and behind it, will roll it forward against the concave wall *O*, which will hold it and assist it into its chair. By this time the chair *M*, will have carried the ball 1, as high as the shaft *C*, and be about to throw it into its path between the guides *L* L^1.

Thus in ascending, the chairs are always full, but in falling each ball passes the chair next ahead so far that that chair comes from behind and catches it. It is estimated that in a fall of seven feet that this hammer could strike fifty blows each minute of time.

The plunger *N*, is upheld by a spring. In this construction it is supposed to hold a die to strike up a medal or coin. The device to feed the work may be of any pattern and be operated by the endless belt or by the sprocket-wheels. The bar *P*, is high enough to permit the chairs to freely pass under but the bar *Q* must be high enough to admit the balls 1 and 2. The header A^1, is designed to facilitate the bracing of the frame *A*, to a wall or ceiling.

While here but one arrangement of this invention is possible, it is obvious that modifications of it would be found of service in many kinds of presses and hammers as well as pile drivers.

CIVIL ENGINEERING.

"ENGINEERING is the Noblest Study of Man" was the utterance of Mr. Francis W. Parker in a paper recently read by him before the Chicago Electric Club; that is to say, "if we take the word in its broadest signification." Such is the signification of the word as used in the title of this magazine, and the words of Mr. Parker afford a text for a short sermon upon this topic. An all-round engineer requires a longer period of study to qualify himself thoroughly than a member of any of the so-called learned professions; that is to say before he can enter upon the general practice of his profession with an average chance of success and profit. The recent additions to knowledge in the physical, chemical and mechanical sciences, have not only enlarged the field of engineering operations, but have also greatly lengthened the approach to the higher walks of the profession. Practically the study of law is the same to-day that it was fifty years ago. The same may be said of theology, in so far as the time requisite for preliminary study is concerned. The study of medicine by progress in chemical science and pathology has been somewhat widened in its scope. Surgery has also been much extended through mechanical and electrical and optical inventions, and progress in the knowledge of the action of septic influences upon wounds; but these extensions are comparatively small when the enlargement of engineering science (in which generalization are included all physical, mechanical and chemical sciences) is comprehensively viewed in its bearings upon the profession of engineering. Resources and materials are multiplying on every hand. In electricity alone, is a field of study almost as broad as the whole course of preliminary study required of engineers forty years ago. In fact, engineering, as a whole, is now a field too broad to be covered by any single mind, and specialized work is becoming the rule rather than the exception. Nevertheless, success in specialized work now requires sufficient knowledge of the entire field to compel a large expenditure of time and earnest effort in its acquisition. The lawyer, after acquisition of the general principles of common law, thereafter deals mostly with precedents. The medical practitioner depends in the administration of remedies mostly upon empirical knowledge. The theologian is usually bound to accept authorities. The engineer worthy of the name is neither controlled by precedent nor authority. His thought, opinion and action are based upon fundamental, well-ascertained laws and facts. His methods are essentially scientific. He accepts implicitly only that which has been proved either by himself or others, and the demonstration of which he has himself scrutinized to determine its truth. In short his entire training, and the daily work of his life being directed to ascertaining exact truth, it can scarcely be denied that the study of his profession is "the noblest work of man."

A Simple and Useful Instrument Designed to supersede pen-work in all kinds of lettering on plans, drawings and maps, has been invented by United States Assistant Engineer J. A. Ockerson, C. E. Every one who has had anything to do with maps or plans, knows how easy it is to spoil a good drawing with bad lettering. Experts in lettering are rare, and the process is slow and tedious. With this instrument a novice can do lettering of all kinds, in quantity and quality satisfactory to the most exacting. The device is said to have been adopted on the United States Surveys of the Mississippi and Missouri rivers, after a most thorough test on a large amount of work. Any style or size of letters or figures may be selected from a type founder's catalogue. Words that are frequently repeated, such as "Plan of," "Section of," "Map of," etc., can be prepared on one block, in such form as may be desired. The style of lettering adopted by an indi-

vidual firm can, by the selection of type, be made to be quite as distinctive as the style of the drawings themselves. The application of this invention to topographical mapping in placing on the maps conventional signs, for which purpose it has been adopted and used on the topographical and hydrographical Survey of the Mississippi River in which over 3000 square miles have already been mapped on 260 Antiquarian Sheets (size 31″x53″), has proved that the time saved by its use in making drawings of even moderate size is diminished to a most wonderful extent. The saving in cost is claimed to be fully 60 to 75% over that of the old method with the pen. The draughtsman does not need to be a topographical expert, as any one can operate the device. A uniformity in a series of maps almost impossible to obtain even by the most expert draughtsman, is secured. After completion, the map made with it is ready for reduction by any of the photographic or other methods. The original map may be transferred directly to stone and printed without any intermediate steps, such as are usually required by using lithographic transfer ink on the regular transfer paper for the original sheet. It is stated that 62 topographic and hydrographic maps (42″ x 72″) of the upper Missouri River have just been completed with this mapping and lettering device, the area covered by conventional signs being extraordinary; yet the total time occupied in making them was an average of one map for every five days. The execution of 36 square inches or more of sand bar, which in the old method by pen must be made dot by dot, can with this device be executed in one minute. Messrs. A. S. Aloe & Co., mathematical instrument makers of St. Louis, Mo., are supplying outfits for this kind of work to engineers desiring them, Mr. Ockerson having applied for a patent, and given them the control of its sale.

Causes for Flat Wheels were exhaustively treated in a paper from the pen of Mr. Paul Synnestvedt, general air-brake inspector of the Chicago and Northwestern Railroad, printed in a recent issue of the *Railway Master Mechanic*. The author of this able paper states that these causes are "the question of the most vital interest to the railroad air-brake expert." He regards "an epidemic of flat wheels" as "evidence of a diseased condition of the air-brake system" which in such cases "requires treatment." In the term "air-brake system," what Mr. Depew has styled the "human element" is obviously included. Mr. Synnestvedt states that although "theoretically a wheel will not slide until the pressure on the brake shoe becomes greater than the weight on the wheel," the law does not hold good practically on slippery tracks, whereon the wheels will slip when the pressure of the brake-shoe exceeds ninety per cent. of the weight carried. It fact he instances conditions of very slippery tracks, whereon the wheels may be caused to slip by the action of much less pressure. Wheels are more liable to slip at low than at high speeds. The reason for this is not explained by Mr. Synnestvedt, but the explanation doubtless lies in the fact that the wheel at high speeds has a much higher momentum which tends to prolong its rotation after the brake-shoe is applied, than it has at low speeds, thus obeying a law common to all rotating bodies. "The cause of nearly four-fifths of the slid flat wheels on all roads," is the use of a "a train pipe pressure above the standard, generally seventy pounds, at which the breaking power is figured." The remedy prescribed for this by Mr. Synnestvedt is "close attention to the condition of the air pump governors." Another cause of flat wheels is "too short a travel of the piston under the car, resulting in increased equalized pressure." In this connection the author states "a fact not generally known, that except where the pressure of an auxiliary reservoir and brake cylinder are fully equalized, a car having 4½ inches of travel does twice as much braking in light applications as is done by one having 9 inches travel. A third cause is "injudicious use of the brake" (the human element comes in here) the most frequent error being "applying full pressure while running at low speed." Upon this point the author enlarges, and traces the fault to the risks

taken by engineers under the realization of the fact that if they do not make time on their runs, their places will be filled by others who will. They are thus tempted to take the chances of sliding wheels rather than either to consume too much time in stopping, or to run by the stopping point. The paper further discusses the proper method of handling brakes, but space will not admit a more extended notice at this time.

The First American School of Marine Engineering and Naval Architecture that has become organized up to the working point is the Graduate School of Marine Engineering and Naval Architecture at Sibley College, Cornell University, Ithaca, New York. Such an addition to the technical, educational facilities of the country merits special attention, and, doubtless its opportunities will be eagerly sought by young men ambitious to enter the alluring field of naval construction. The school was organized in September, 1891, by the appointment of Prof. W. F. Durand, late of the Engineer Corps of the United States Navy, as Principal; and by the appointment, later, of Prof. G. R. McDermott, late with J. and G. Thompson of Clyde bank, as assistant in Naval Architecture. A letter from Prof. Durand states the object of the school to be to provide American students, already familiar with general engineering, such courses of both theoretical and practical studies as are necessary to show the appreciations of engineering to the design, construction, powering and propulsion of vessels of all types. These courses, as at present arranged, cover a period of two years. The necessary preparation is that given in most of the undergraduate courses of the technical schools in the United States. The study of existing designs and the subsequent preparation of original designs will be a prominent feature of the courses. Provision will also be made for advanced research in lines closely related to marine engineering. Prof. Durand suggests that there is offered an opportunity to those interested in the progress of marine engineering in this country to come to the aid of the institution by additions to its endowment, and it is hoped that such a distinct and important step in the progress of technical education in this country may not be retarded by lack of substantial assistance.

The Life of Iron Railway Bridges, according to English and German expert authorities, does not exceed seventy-five years. In many instances a shorter period of use renders them unsafe. This conclusion is the result of special investigation instituted by European governments to determine the durability of railway bridges. Nothing in ancient or modern construction has ever been discovered that, in point of durability, is superior to good solid masonry for bridges. The advantages of cheapness, rapidity of erection, etc., will, however, probably continue for a long period the use of iron for bridge construction.

As to Road-Making and Repairing, which is just now one of the most prominent engineering subjects before the American public, a most valuable paper was read by Mr. James Owen, of Montclair, N. J., before the Road Convention, recently held at Trenton, N. J. The paper, full of valuable and practical information, contains views with reference to the relative expense and effectiveness of draining wet places, as compared with the too common makeshift of filling them up, that cannot be too widely disseminated or too strongly enforced upon the minds of all concerned in the construction or maintenance of highways. "In ninety-nine cases out of a hundred," said Mr. Owen, "it is cheaper to dig or ditch, to drain a hole or pocket or swamp, than it is to fill the place up, yet to my knowledge money, time and energy have been wasted in filling with stones and boulders wet and low places in roads, with still unsatisfactory results, when, if one-tenth of the time and energy had been consumed in draining these same places permanent success might have been insured. In one particular case I remember, on a road that had been travelled for over 100 years, and during that period stones and boulders had been dumped to keep teams and loads from getting mired, on my proposition of lowering the grade of the road and removing these stones I was solemnly assured of

the folly of such a proceeding and undoing a century's work. The result, however, proved the contrary, as a good road has existed ever since the new grade was made." Mr. Owen adds the injunction that care should be taken to drain from the lowest points and with proper grades. If the grades be long, it may be advisable to drain from intermediate points.

A Disastrous Contract to the contractor, the construction of the Third Avenue cable railway in New York City seems to have proved. Nothwithstanding his previous extensive experience in the construction of street railways, the job appears to have presented such difficulties as to appall and dishearten him, and it has been asserted that he became very tired in a short time after beginning it. It was a monster contract in all senses,—no less than the completion of the road from Ann Street to One Hundred and Thirtieth Street between the dates of March 1 and October 1, 1891. Among the most serious difficulties in the work was the rock excavation; of this work there was many times more than the contractor is said to have counted upon, though, after reading the discussion of the rapid transit question by Mr. T. Graham Gribble in the May and June (1891) numbers of this magazine, and the item headed A Very Costly Job in the department of Civil Engineering in the June (1891) number, he might have learned that there was need for more than usual caution in undertaking to cut through the hard rock which constitutes so much of Manhattan island, particularly in streets built up on both sides, where heavy blasting is impossible, and wherein numerous gas pipes, water pipes, steam pipes, electrical subways, etc., often preclude any blasting at all. The contract seems to have been entered upon too hastily, and without a due exercise of ordinary prudence.

As to Cement Mortars, a recent article in the *Revue de Génie Militaire*, by M. R. Feret, points out that, notwithstanding the advantages of the usual methods of mixing the cement by weight with sand by measure, the method is uncertain in its results, on account of the impossibility of an accurate apportionment of the sand by this method, the variation dependent alone upon the moisture in the sand, often amounting to twenty per cent., moist sand compacting in measuring much more than dry sand. The varying size of the sand grains is another source of error, the percentage of voids varying greatly. In further estimating the effect of sizes of grains upon the aggregate space of voids *Engineering* (London) describes some interesting experiments performed by M. Feret with artificial sands made by crushing quartzite: "The sand as received from the crusher was graded into three degrees of fineness. The first consisted of such grains as would pass through a sieve containing four meshes to the square centimetre, and were retained on a sieve of thirty-six meshes per square centimetre. The second consisted of grains passing through a sieve of thirty-six meshes per square centimetre and retained in one of a much finer mesh, whilst the third consisted of the grains passing this last sieve. Measured dry, each of these samples had practically the same specific weight, No. 2 being slightly the lightest. Mixed in various proportions it was found the mixture having the highest specific weight was one consisting of six parts of the first sand and four of the third. This weighed 1686 kilogrammes per cubic metre, or 30 per cent, more than No. 2."

Machinery for Road-making and Repairing is to be made the subject of competitive tests during the coming summer by the Engineering Association of the South, which has appointed a committee of its members to prepare a detail scheme for carrying out this purpose. An extensive correspondence has been made the vehicle for suggestions from all parts of the country, and the tests now promise to be of much importance and interest. The recognized ability of the engineers composing the association is sufficient warrant that, as a result of the projected tests, valuable data will be added to present knowledge upon the subjects of road-making and maintenance, provided that the manufacturers of road-making machinery and appliances cordially co-operate in the scheme.

ARCHITECTURE.

ELECTRIC Heating for dwellings is a seemingly natural sequence of electric lighting. At present, however, its cost will prohibit any general adoption of what may at some future period become a common method of warming not only private residences, but public buildings also. In the grand march of discovery and improvement no one can venture to predict what *may* come; he would be still more rash who should prophesy what *may not* come, provided it be compatible with established natural principles. There is nothing impossible in the supposition that heat may at some time be made economically the direct source of electricity, and when this point shall be reached, heat derived from the electric current may render the latter as economical a conveyor as steam or hot water in pipes and radiators. Nay, it is within reasonable possibility that solar heat, first converted into electricity, and reconverted into heat of higher intensity may supply, in the future, not only dwellings and public buildings with needed warmth, but may supplant coal for industrial purposes also. In the department of Electricity in the present number is given a statement of economy already reached in electric car-heating, interesting in this connection. It has been computed recently that electric heating for domestic purposes is about five times as expensive as heating by ordinary methods; and probably this is not far from correct. The chief loss is in the first conversion of heat into mechanical power for generating the electric current. In the direct generation of electricity from heat, some loss must also be incurred, as loss is incident to any conversion of one force into another. By this, is not meant an absolute loss of the total store of force in the universe, but a loss of the particular form of force so converted. That is to say, the electric force derived from the heat will never be the full equivalent of the heat expended to produce it, some of this heat being inevitably expended in other directions; but it cannot be doubted that the waste will be less in a single conversion than in two. Absolute cleanliness, accurate control of temperature, instant starting and stopping of its action so that consumption ceases with need for it, a minimum of space, and exact distribution are among the desirable advantages obtainable from a system of electric heating. To reduce cost from present conditions to a point of reasonable economy as compared with other heating systems, is the problem to be solved. When this is done, electric heating will be as common as electric illumination.

A Significant Indication as to the future of the tall building mania, is the attitude of insurance companies with reference to risks incurred in writing policies for them. This attitude is decidedly hostile. The risks are estimated as much greater than with other structures of moderate heights, and rates hereafter, at least on the part of the New England and Chicago underwriters, will be adjusted with direct reference to height. At a recent conference of the New England Insurance Exchange Committees with the Lynn Board of Underwriters a new schedule of rates was adopted in which an extra charge for buildings over four stories in height was incorporated, to wit, fifteen cents extra for five-story buildings, forty-five cents extra for six stories, and $1.05 cents extra for seven stories. Extra charges for taller buildings have not been announced by the New England underwriters so far as known at present writing, but, if adopted on a scale inferentially proportional to that above stated, they must prove a serious obstruction to future tall building projects, to say nothing of the effect upon present invest-

ments in this kind of property. In Chicago the Fire Underwriters' Association is also making a dead set against the erection of tall buildings. A correspondent of *Architecture and Building*, states that the losses from fires in that city for 1891, amount to $3,000,000, this aggregate being the highest ever known in the history of Chicago, except in the year of the great fire, and he adds that the losses throughout the country have been so heavy that fifty fire insurance companies have been forced to abandon the business. In view of these losses, the association resolved to increase rates of insurance on tall buildings to a figure at which it will almost be impossible for owners to carry insurance on such property. It is stated that it will cost $2.50 to insure one hundred dollars on the tenth story of a building, and that insurance on a ten-story building worth $500,000 will cost $10,200. The association further resolved no longer to make allowances for so-called fire-proof construction "in buildings *where merchandise is stored*," or for fire-proof linings and self-closing doors in elevator shafts; while, at the same time, if these latter are absent, they will increase rates on account of the deficiency. The correspondent above quoted regards this stand on the part of the underwriters as almost a death-blow to future tall building, and, if rigidly maintained, it can hardly prove otherwise. He concludes his letter with the allegation that merchants cannot cover their stocks by insurance in such buildings, that no company can or will carry them," and that, as a consequence, "many of the big dealers in Chicago are walking about to-day only half protected." The slightest reflection will convince any one that such a state of affairs will not last long, and that the rentals of tall buildings must be seriously affected by this action of the underwriters.

Automatic Sprinklers over the stages of theaters having been objected to by Mr. Ernest Woodrow in the columns of the *American Architect*, Mr. Edward Atkinson in a communication to that excellent journal, implied some doubt of the justness of Mr. Woodrow's conclusions. The objections of Mr. Atkinson appear to have been pointed at the following paragraph in Mr. Woodrow's article:

"In some theaters water-sprays or rows of perforated pipes are placed over the stage, but I do not think one can place much reliance upon them, especially where they are brought into play by an automatic action, such as the melting of solder by the heat of the fire, thus actually requiring the presence of the very enemy they are provided to subdue, before they can be brought into action. I have elsewhere spoken of the evil in placing trust in mechanical automatic appliances of any sort; where reliance is put on these as safeguards, and the ordinary and more effectual precautions are left unprovided."

Mr. Atkinson basing his views upon experience with factory buildings, and also upon the "record of complete success in the automatic sprinkler system in extinguishing fires in theaters," states that he has "urgently recommended it for that purpose." To which Mr. Woodrow replies that the system is undeniably good for factory buildings, but that the latter cannot be properly compared with theaters, in which different conditions have to be met. Upon this point he makes the following remarks which for want of space are somewhat condensed:

"The height from floor to ceiling of a factory is considerably less than the height, from stage to girdiron, of a theater, where the sprinklers are situated, about 60 feet. Before an automatic sprinkler could be set in action on a stage by the presence of flame, the fire would be past all the auxiliary aid of pumps, hydrants, etc. If a sprinkler be set in action by the presence of heat alone, it will be subject to this same condition by the accumulated heat over the stage, apart from the actual presence of fire. It will doubtless be asserted that the extract ventilating-shafts over the stage will keep the air sufficiently cool to prevent such an accident as an unexpected shower of water from the automatic sprinklers; but my experience is, that theatrical people hate ventilation and fresh air, and six months or less after the building leaves the hands of the architect, every ventilator is effectually stuffed up. It is needless to again draw attention to the awful consequences that would follow an alarm, through the inadvertent starting into action of an automatic appliance, indicating the presence of the danger it was designed to avert. An automatic sprinkler, without fire, would be equally appalling in its consequences to the fire itself. Panic

kills more people than fire, and in this particular factories and theaters cannot be compared. I may add that these views are held by the London architects who make theater-building their specialty."

Mr. Woodrow also by implication appears to entertain some doubt of the record relative to the use of automatic sprinklers for theaters spoken of by Mr. Atkinson.

A Useful Lesson may be learned from the results of the competition for the projected public library building in Chicago. It appears, that the board in charge of the competition undertook by a set of instructions to control in advance the character of the designs, a scheme that may be aptly compared to ordering a landscape to be painted, under specifications that a lake shall occupy one part of the picture, while various other parts, as mountains, animals, boats, clouds, etc., of specified sizes and forms shall make up the rest of the picture without any reserve of space for the exercise of skill or judgment in the composition and execution on the part of the artist. Of course, any artist worthy of the name would reject such a proposition. The able and prominent architects of the country have done likewise with the impracticable and absurd scheme of the Chicago library board and the competition has resulted according to the *Northwestern Architect* in the presentation of a few feeble and worthless designs which, notwithstanding their character will have to be paid for at the rate of $1000 each. It seems to have been the idea of this sapient board that they could prescribe a design, that architects would undertake to execute. It was a sort of "every man his own lawyer" scheme, in which of course, any established architect of repute would refuse to co-operate. If the board that has thus conducted its ridiculous fizzle to the inevitable outcome will read Mr. Beverley Robinson's article published in our March number, entitled "What an Architect Does for His Money," it will probably be wise enough after such perusal, not to waste money upon another competition for plans expected to fit prescribed lines established in advance by its own incompetence.

The Heating and Ventilation of American Theaters were discussed in a very able paper read before the Royal Institute of British Architects by Mr. H. Townsend, at a recent meeting. In this paper Mr. Townsend said that having resided in the United States for twelve years, during four years of which time he practised his profession, he had had exceptional opportunities for studying American theaters; and in all their architectural features he made a comparison between them and English theaters very favorable to those of the United States. With reference to the heating and ventilation Mr. Townsend said that in America ventilation was nearly perfect in all the later theaters, naming in this connection those of most importance in the principal American cities. An important advance specially commented upon in the discussion of the subject, is the introduction of artificial cooling in the summer, first done in this country, a system which is intimately connected with ventilation, inasmuch as the cooling is accomplished by the introduction of air previously brought down to a proper temperature. Into the details of this system Mr. Townsend did not enter. Ice has been used hitherto, but in the article on "The Manufacture of Ice" by Mr. Leicester Allen, printed in our March number, the application of refrigerating machines to this purpose is foreshadowed, and a mode of application is clearly outlined.

The Superior Strength of the Ancient Roman Cements, supposed by most people as far beyond that of modern cements, turns out to be a myth. Mr. Edward Ball recently read a paper before the Toronto Architectural Club in which he asserted, "that with all the advantages they have had in hardening slowly from two to three thousand years, probably none of them is equal in strength to good Portland cement mortar made of one part cement and two parts sand *one week old*." His paper gives an account of the discovery of Portland cement in 1824 by Mr. Aspdin of Leeds, England, while experimenting with some of the overburned clinkers of artificial cement which was then being manufactured. Because in hardening it assumed

the appearance of a limestone quarried for building purposes on the Isle of Portland, he gave it the name "Portland" in his application for a patent on the invention. It is well known that the presence of magnesia is very injurious to Portland cement, but the explanation of the action whereby the injury is effected is not popularly understood. Mr. Ball says that the magnesia "may not prevent the cement from setting and becoming apparently as hard as though it were absent. For a long time it may remain inert, and perhaps for months there may be no apparent change. The magnesia, however, has an affinity for water; every two pounds of magnesia in becoming hydrated, takes up and solidifies one pound or 27.7 cubic inches of water, and in bulk every ton of magnesia would have to find room for about 16 cubic feet of water. In finding room for this water the mortar becomes disintegrated. The action continues whether in air or in water, and is especially disastrous in concrete work. Instances are recorded where concrete works have failed although built in the usual manner with cement that had stood the ordinary mechanical tests."

The Copying of American Systems of Building is said to have brought disaster to many structures in Japan during the recent earthquake. Eager to adopt customs pertaining to other civilizations, the people of that enterprising and interesting nation seem willing, without question, to appropriate dress, manners, religions and habits in many cases not as good as their own. The Japanese dress is incomparably more tasteful than that of American and European peoples, and in numerous ways there is manifested a peculiar genius and picturesqueness of race that to extinguish by absorption of western manners and customs, would be something to be regretted. If upon this stock could be grafted the thirst for modern science and the useful improvements of our age without at the same time substituting the follies, superstitions and vices of modern society for ancient ones of their own which science would ultimately teach them to renounce, there would be a "promise and potency" in the character of the Japanese race from which might spring a civilization of higher type than the world has yet seen.

A New Artificial Stone made by a purely mechanical process, and involving no chemical action except such as is concerned in the setting of Portland cement, is described in English papers. The stone is composed of two parts, comminuted Scotch granite and one part of Portland cement, the mixture being shaped in molds under hydraulic pressure. The stone is described as dense, free from unfilled air-spaces, and sufficiently hard for use, not only in building, but as a paving material. Its resistance to crushing is said to be very great, one square foot of it having a thickness of 2⅛ inches, giving way only under a pressure of 413.1 tons. The cost of manufacture is also said to be such as will be likely to encourage its use in all kinds of stone work.

The New Public Library in Boston, will, when its interior is completed, be one of the handsomest buildings of its kind yet erected in this country. It is now announced that some of the foremost living artists have been engaged to perform this part of the work, some of these being from abroad. It is understood that the decorative work is to be paid for by private subscription on the part of public spirited citizens of Boston, and that the large sum needed for the purpose has all been subscribed.

The Diminishing Supply of White Oak is said to be creating a demand for red oak as a cheaper substitute for some purposes for which white oak has hitherto been used. This substitution has been more particularly marked in the car-building trade, according to *Hardwood*, a lumber trade paper published in Chicago. Red oak bends well, and is valuable for door-stiles, rails and some other parts of the interiors of cars. The beauty of white oak, and its adaptability to furniture manufacture have gradually increased the demand for it to an extent that enhances its cost; hence the desire for a material that can be used in connection with it for interior finish. Chestnut is a beautiful wood, easily worked, and durable, but it has the defect of great porosity.

ELECTRICITY.

THE Improvement of Church Organs through various applications of electricity has made greater progress than most people know. A recent address, entitled The Electric Control of Organs, by Mr. R. Hope Jones, who has become somewhat famous among English electricians on account of the special attention he has given to this subject, was delivered before the National Association of Musicians at Leeds, England. In it he declared, that in his opinion, electric actions for organs will soon supersede other actions, whether for large or moderate sized instruments. Sufficient current could, in his opinion, be supplied for a large four manual organ by a single dry cell, and the light touch of the electric action cannot be obtained by any other in use. The response to the touch is so nearly instantaneous as to render the utmost rapidity of execution possible. This rapidity has been mechanically tested, and it has been found that clear and distinct repetition at the rate of 1300 notes per minute is possible. Other advantages secured, as named in an abstract of the address published in the *Electrical Engineer* (London) are a "movable console; stop keys, saving the organist labor and giving better control of the registers; the stop-switch, by which a combination of stops might be arranged beforehand and brought into use at the moment required; unlimited combination touches; keys or studs for the automatic control of the pedal registers; suitable accompaniment; unlimited couplers; increased control of the swell shutters; and the transposition switch. The only single disadvantage that could be named was the need for a supply of electric current, but as they could obtain all that they required from a single cell, they need not fear inconvenience from this." Mr. Jones said with reference to the experimental organ in St. John's Church, Birkenhead, that "a year ago that instrument was of little interest to any one but himself and the choristers, who helped him to build it. The organ had, however, during the year been visited by nearly 1500 musical gentlemen, and 23 London and provincial organ builders were now engaged in the introduction of the system."

Heating by Electricity appears to be making greater progress as applied to railway cars than in other fields. Obvious reasons for this are that it takes less space than other modes of heating, allows the seating of more passengers, and hence compensates, at least partly, for greater cost by increase of carrying capacity. Whether the actual cost of electric heating for buildings will ever compare economically with ordinary method, will depend upon future discovery, but its advantages of cleanliness, perfect control, convenience, distribution and economy of space are such as may in time overbalance considerations of actual cost for many purposes. In the department of Architecture in the present number these advantages are further considered. In a letter to the *Electrical Review* recently published, and contributed by Mr. W. R. B. Wilson, are some interesting statements of the cost of electric heating on electric railways, which seem to show that it is much cheaper than stove-heat. He bases his figures upon reports of two different roads, using what is known as the "Burton" electric heater, and adds that "reports from other roads tell approximately the same story." The first example cited is that of a road using 3 amperes or 2 horse-power per set of 4 heaters, 4 pounds of coal per horse-power per hour, 144 pounds of coal per 18 hours per car day, and in which the cost of coal was $1.75 per ton. On these data he computes 1 pound of coal, $.000875, 144 pounds of coal, $.12528, cost per car day, $.12¾, cost of stove heat, $.25 per car day. In the

second example are used 3 amperes or 2 horse-power per set of 4 heaters, 4 pounds of coal per horse-power per hour, 80 pounds of coal per 10 hours per car day. From which are estimated cost of coal, $3.75 per ton, 1 pound of coal, $.001875, 80 pounds of coal, $.15, cost per car day, $.15, cost of stove heat, $.35 per car day. It will be seen from these figures that there is a notable economy in favor of electric heating. It would have been interesting to have had in connection with the detailed statement of the cost of electric heating something more than the lump cost of stove heating. The figures are so favorable to the electric system, as to suggest a probable waste in the use of stoves, which, obviated, might make a different showing.

Interesting Details of the Survey of the High-Speed Long-Line Electric Railway, mentioned in this department in our March number, have been forwarded to us by Mr. Arthur Thatcher, Secretary of the Engineers' Club of St. Louis. It will be recalled that this road is to be built between St. Louis and Chicago, and that the speed to be attained is fixed at one hundred miles per hour, the power to be taken from a single power-station situated midwise with relation to the line, and in immediate proximity to a coal-mine owned by the corporation. The description of the survey was presented to the club by Prof. J. B. Johnson at a recent meeting. As stated in the notice of this road printed in our last number, the survey is proceeding in a direct straight line from a chosen point in East St. Louis to a chosen point in Chicago. "A casual inspection of the region to be traversed indicated that a straight line road would probably fit the ground as well as any other, and would not pass through any town or village of importance, which for a high speed road is very desirable. The question of grade also is unimportant in this case, since grades as high as 5 or 6 per cent. can readily be overcome by a single or double car electric service. Since the proposed speed is 100 miles per hour, it is a real advantage to avoid curves. If a straight line can as well be secured, therefore, as any other, it is thought best to do so. The direction of this line has been computed from the known latitude and longitude of the two terminal points, and the line is being run by a transit, the forward points being set by double reversals of the instrument, and bisecting the space between the two positions. The Azimuth of the line will be checked every ten miles by observations on Polaris, made at any convenient hour, using a table especially computed for such work." The title of the corporation that proposes to construct the road in time for use during the Columbian Exposition is "The Chicago and St. Louis Electrical Railway Company."

Electric Lighting for the City of Rome in Italy, when the history of that capital, its conservative religious atmosphere and ancient associations are remembered seems almost incongruous, yet it is to be carried out. The spirit of modern innovation little regards the odor of antiquity, and reaches everywhere, careless of associations, ancient landmarks, or legends. At Tivoli is now being constructed the power station that will supply the current. This station will furnish 2000 horse-power, derived from the Falls of Tivoli. The *Scientific American* says, "Nine Pelton wheels will be used to furnish the current which will be generated by six alternators each yielding a current of 5000 volts and 45 amperes. It is intended to keep constantly one of these alternators in reserve, five only being required for the actual work contemplated. As the power station is some fifteen miles from Rome, a loss of twenty per cent. in voltage is expected in transmission, which latter, it is stated, is to be accomplished through standard copper cables supported with double shed oil insulators specially designed for the purpose by Prof. Mengarini."

The Universal Demand for rapidity in all departments of business activity is constantly urging invention to produce not only machines for rapid work, but rapid methods in the use of such appliances as are already in use. One forcibly feels this insistance in perusing an article on "Telegraphic Shorthand," recently contributed to the *Electrical Review* by Mr. John H.

Gavit. As in many other instances, this pressure for increased rapidity originated with the newspapers, and as Mr. Gavit expresses it, "somebody had to devise a means of progressing still further toward the infinitely rapid and the infinitesimally short," since the acceleration gained by the use of numerous abbreviations had reached the utmost limit possible to transcription by the use of a pen. Mr. Gavit narrates the history of the discovery and introduction of the new system, by which a very great extension of the system of abbreviations in telegraphy has come into use, the code of abbreviations known as the "Phillips' Code," having been invented by Mr. Walter Phillips, general manager of the United Press.

"This means of using this telegraph shorthand was discovered largely by accident, through the typewriter. A few newspapers furnished machines, a few operators bought them for themselves. Then the telegraph editors whose operators still clung to the pen and the stylus began to demand typewriter "copy," and the number of typewriters increased. At this stage in the proceedings it was found that a fairly proficient typewriter operator could receive faster than the fastest man could send, and then it was that the abbreviations began in earnest. Mr. Phillips had, in the meantime, resigned his place on the Chicago wire, and had become general manager of the United Press in New York. He soon saw that with a rapid use of the typewriter his code of abbreviations could be largely increased, yet still be practicable. Thus it was that the 'Phillips' Code' of telegraphic shorthand came into general use. It was very simple at first, but as the operators became more proficient and were able to ignore the clicking of the typewriter and pay strict attention to the telegraph sounder, the number of abbreviations was increased, until to-day the Phillips' Code is a very complete system of shorthand, adapted especially to sending news by wire, but in use also among many reporters."

The Electrical Plant of the Chicago *News* is said to be more complete and comprehensive than any hitherto introduced into a newspaper building Two 60 Kilowatt-Edison dynamos are used and they supply current for 650 incandescent lamps, 24 Ward arc lamps and a number of electric motors of various sizes developing a total of 50 horse-power. The switch-board is one of the most interesting features of the installation. The *Western Electrician* in an illustrated article describing in detail the entire installment, gives the following particulars of the switch-board:

"This interesting switch-board is built of quarter-sawed oak, matched and headed, and highly polished. The conductors used upon the switch-board and ceiling are of polished copper bars and rods, held in place by brass cleats mounted upon insulating slate bases. All switches and cut-outs are of polished brass composition, mounted upon slate bases, and especially constructed for this installation, the minimum amount of space requiring compactness in design. The switch-board was constructed with an especial view to ease and dispatch in its operation, and is one of the most complete, in detail, arrangement and flexibility of operation in Chicago."

As to the Conversion of Solar Heat into Electricity, and the reconversion of the electric current into heat of greater intensity in the not improbable future of the art of warming buildings, an article from the pen of S. Tolver Preston, printed in *Engineering* (London), affords some justification. This eminent electrician and physicist expresses the opinion that "the correlation of electric phenomena with heat" is a "more practical view," than "the identity of electric disturbances with light"; and he seems to think it probable that a considerable portion of the solar energy is spent in long ether waves, like "the long ether waves that oscillate about an electric circuit or constitute such a circuit."

A Simple Heat Engine, being nothing more than a rotating disk of nickel suspended on an axis between the poles of an electro-magnet has been produced by Mr. Frederick J. Smith who has communicated a description of it to *Nature*. It is an extension of the experiment of Mr. Shelford Bidwell. It will be remembered that a continuous motion in the nickel bob of a pendulum, was kept up by the action of a lamp and a magnet in Mr. Bidwell's experiment, the action being based upon the fact that nickel loses its magnetic power at a

definite temperature. The magnet attracted the bob toward it where upon being thus brought to the proper position in relation to the spirit lamp, it was heated to the temperature at which it ceased to be magnetic, and, swinging back again away from both the magnet and the lamp cooled enough in this oscillation to again become magnetic. The pendulum was thus kept in continuous oscillation. In Mr. Smith's modification of the experiment of Mr. Bidwell, one side of the nickel disk being heated, the cooler side is attracted, and as the movement of the disk causes all parts to be alternately heated and cooled the movement is continuous. At present the experiment exhibits merely a scientific toy, but some very large things in the arts have grown out of smaller germs than this.

Apropos of Typewriting for Receiving Operators, an extension sounder support and resonator described in the *Electric World* is an interesting, and seemingly, a very useful invention. This sounder is so arranged that it can be brought "close to the receiving operator" and our contemporary states that the "volume of sound can be so greatly increased that it can be heard over outside noise. Moreover, the instrument may be adjusted so that no one can hear it except the receiving operator. The increase of sound is effected by inclosing it in a resonating box, and its adjustment into any convenient position desired is accomplished by supporting the box "by a swivel pendant on a swinging arm," this arm also being adjustable for height. The resonator may thus be brought very close to the ear, whereby the receiving operator not only hears it very distinctly above all other noises, but no one else can hear it at all, thus materially lessening the volume of confusing sounds in rooms where several operators are at work simultaneously.

An Electric Railway for Berlin, and also of the elevated type is on foot, plans for the same having been prepared by Messrs. Siemens and Halske. The scheme, which yet awaits the approval or disapproval of the German Government, contemplates the use of single motor cars run separately at from two to three minutes headway, except when an extraordinary traffic demands the making up of cars into trains. From 150,000 to 175,000 passengers annually can be expected according to the estimates of the projectors, and the cost is placed at about $600,000 per mile. It would seem that the system of running trains instead of single cars, with a longer interval of headway would insure greater safety than the system of single cars, unless the system includes a positive block system, and the latter would be found rather cumbersome with single cars running with two minutes headway.

A Curious Influence of Steam on Magnets, said to have been detected by recent investigations, is announced in the *Schweizerische Bauzeitung*. Continued heating in steam is asserted to abstract from one-fourth to two-thirds of the magnetic power; but if, after this heating, the magnet be again magnetized very little loss is effected by a second heating. An extension of the experiments is stated to have indicated that not only is the magnetism rendered more resistant to heat by this treatment, but that it also resists more obstinately deteriorating mechanical influences, such as blows delivered upon it; and that, hence, more permanent magnets than heretofore could be obtained are now possible. The truth or falsity of these statements, being susceptible of easy proof, will doubtless soon be determined.

The Largest Switchboard in the World is said to be that in the new building of the Bell Telephone Co. in Toronto, Canada. Its capacity is sufficient for six thousand subscribers. The wires are to be laid on what is known as the "interior conduit system." All the wires are covered with rubber and incased in insulated tubes which are also waterproof and fireproof, and in such manner that wires may be drawn out and others inserted at will.

The Champion Telephone subscription list is said to be that of the city of Berlin, which according to *Electricity* numbers about 17,000. The increase in the United States for the past year has been 40,000 subscribers, and in Paris the subscription has been nearly doubled in the same time.

MINING AND METALLURGY.

THE Great Strike in the British Coal Fields, in which nearly half a million of coal miners went out, has been the most notable recent event in mining affairs, the explosion in the Anderlues mine, perhaps, excepted. The number of men who quit work and the instant panic that seized British manufacturers, impress upon the popular mind, as nothing else could, two important facts. The first is the almost entire dependence of the world's industries upon the regular supply of coal; the second is the almost "hand-to-mouth" character of the coal trade. The strike has revealed the startling fact, that so little stock of coal is carried, as a rule, that even a very brief intermission of coal-getting may bring a large number of the most important British industries to a stand-still. Probably a strike equally general in the coal mines of this country would begin to embarrass a large number of industries in two or three weeks, so that the coal miners appear to hold the key to the industrial situation whenever they can organize with sufficient coherency for concerted action over a large enough field. The only preventive for such embarrassment is to carry much heavier stocks of coal, and to hold these at points convenient for transportation and distribution. With coal on hand to meet all demands for, say, six months, without material advance in its price, it is hardly possible to imagine a strike of such vitality and magnitude that it could survive and retain strength enough to maintain vigorously its contention beyond this limit. The number of hands specially employed in getting and distributing English coals, exclusive of hands employed in transportation is said to be upward of 600,000. With means and perfect organization, this enormous body of workers would have the power to stop, and even ruin, all the manufacturing industries of the realm, which is equivalent to saying they could ruin British commerce that depends for existence upon cheap coal. To keep coal cheap, wages of miners must be kept down, and the miners themselves must be kept down. The keeping-down process, however, as history plainly teaches, has a limit. Such a strike indicates that this limit is nearly approached, if not actually reached, and that the world is drawing near to a period in which a good deal of history is likely to be made.

Recently Discovered Coal Mines in the Argentine Republic promise so well as to lead to the belief that importation of coal for the railways will henceforth be unnecessary. It is stated that, in consequence of these discoveries contracts for English coals will not be renewed by the railways.

A New Instrument for prospecting in search of gold deposits, is a recent English invention, which has sound scientific principles to back it. The first thought suggested by the name "Portable Gold Finder," under which title the instrument, it is announced, will soon be put upon the market, will be in most minds that this is a sort of new fangled "*divining-rod*;" and, barring the odium attached to the term, and the fact that the so-called divining-rod was never of any use except to the charlatans who gained a livelihood through its employment, the suggestion would not be far from the truth. The instrument or a principal part of it is a rod by which alluvial earths may be pierced. As described in English journals it consists essentially of a steel tube carrying an inner rod that communicates by a wire with a small electric battery carried by a strap over the shoulder of the prospector. When thrust into alluvial deposits and upon meeting with any metallic obstruction, say a gold nugget, an electric circuit is set up, which causes the ringing of a small bell attached to the battery; and the delicacy of this ac-

tion is alleged to be so great that a grain of gold as large as a pin's head will give a vigorous indication of its presence. The inclosed rod or core is removable, and by pulling it out and working the steel tube further into the soil, specimens of the latter at the point where the bell gives indication of gold may be brought to the surface for examination. The instrument being very light and portable is very convenient for the prospector.

The Anderlues Explosion, referred to in a preceding paragraph, adds another terrible calamity to the list of recent mining disasters. The loss of life, deplorable in any event, in this case is rendered still more shocking from the fact that mothers of families are included in it. It has been said truly that much of barbarity still inheres in modern civilization; and no more forcible exemplification of this truth could be cited, than the fact, that in the immediate vicinity of the refined and enlightened Belgian capital, whose beauty and chivalry were sung by one of England's most famous poets, women, mothers of little children, are permitted, nay compelled by the hard exigencies of their lot to labor in damp and noxious mines, and thus imperil not only their own lives but the lives of their offspring. That this kind of labor is anywhere necessitated to women is a disgrace to modern civilization. That mine explosions are so frequent is either a disgrace to modern engineering science which has surely advanced far enough in its resources to solve the problem of prevention, or it is the result of parsimonious administration that will not pay for proper supervision, nor employ the necessary appliances to secure a reasonable degree of immunity from accidents. It is not to be expected that no accidents will happen, but there is a possible minimum that has latterly been much exceeded.

Deposits of Manganese in Cuba, have been investigated by Mr. Eduardo J. Chibas and a report of results has been printed in the *Polytechnic*. The examination is said to have been made in the interest of the industries conducted by Mr. Andrew Carnegie and those associated with him, and is therefore likely to be entirely trustworthy. From the report it appears that the principal deposits of this valuable mineral are located in the Sierra Maestra range in Santiago de Cuba, near the summits and on the flanks of these mountains, and the most abundant varieties of ore are those known to mineralogists as pyrolusite and psilomane. These are generally associated with yellow jasper. The ores are sometimes found imbedded in this rock, and in other instances irregularly distributed over clay formed from the decomposition of the rock. Some of the pockets contain large masses of the ore reported to be very free from impurities, while, in other places, lumps of the ore are mixed in with the clay and jasper. Mr. Chibas states that "average analyses of the cargoes shipped from Cuba have ranged between 47 and 53 per cent. of metallic manganese, 4 and 9 per cent. of silica and between 0.03 and 0.10 per cent. of phosphorus."

"One cargo from the Gloria Mine analyzed as high as 55.21 per cent. of metallic manganese. The most extensive deposits are those forming the Ponupo group, about 12 miles from the Cristo Railroad station. The mining at this place becomes very easy, as, after removing the soil, a man with a pick and shovel can turn out from 3 to 4 tons of ore per day. The ore is placed in bags of about 100 pounds' capacity and carried on the backs of mules or on carts to Christo, whence it is sent by railroad to the port of Santiago de Cuba. The actual cost in round numbers, of placing a ton of that ore in Philadelphia is as follows:

Mining, including labor and all expenses at mines	$1.50
Bagging	1.50
From Ponupo mines to railroad station	5.00
Labor at Cristo and freight over railroad	1.50
Labor at Santiago de Cuba	.50
Freight to Philadelphia, unloading there, insurance and commission	4.00
Average cost of 1 ton of ore	$14.00

This would be equivalent to $12.60 in United States currency."

Mr. Chibas thinks that some cheap railway construction, and a judicious expenditure of a moderate amount of capital would place some of these mines "in a

condition to ship their ores regularly and at a handsome profit."

Among Present Indications of Mining Prosperity, present and to come, may be cited the wire-rope tramway business of the Trenton Iron Works. As a large proportion of wire-rope manufactured is used in mining operations, the amount demanded for that purpose is a pretty sure index to the activity in mining industries generally. The works named have recently built such a tramway for the famous "Holy Moses" Mine in the New Creede District, and now have on hand the following contracts for similar work: One, 8250 feet in length, for the Amethyst Mining Co. in the Creede Camp, capacity 200 tons per day; One 5550 feet long, to be built for the Smuggler Union Mining Co., capacity 200 tons per day, and one for a mine of a group known as the Huggins Mines, in Guanacevi, Mexico, 5960 feet long, capacity 100 tons per day. These works having recently completed a large cable hoist for the Passaic Quarry Co., of Paterson, N. J., they have now a contract for the erection of a similar one for the Avondale Quarry Co. in Pennsylvania. The Trenton Iron Co. has also now on hand the duplication of the large cable transfer over the Susquehanna at Williamsport, Pa. Another contract is the building of an additional tramway for the Pennsylvania and West Virginia Coal Co. in West Va. Besides the above, these works have on hand a contract for a tramway for the St. Bernard Coal Co. in Kentucky, intended for the transportation of culm, and one with the Croton Falls Magnetic Iron Ore Co., near Brewsters, N. Y., for a large haulage plant. The present era of mining prosperity in America is attracting attention throughout the world.

Some Analyses of Steel would seem to be of doubtful value according to a statement in *Industries* (London) which narrates that in order to test the value of analysis a Sheffield manufacturer bored a bar of shear steel, divided the borings into three equal parts and forwarded the three samples to a metallurgist for examination. In return he received three varying reports as to the component parts of the same article. This probably indicates that the skill of the analyst was very unequal in its exercise since it is scarcely possible that the steel could vary. *Industries* does not name the metallurgist that made this triple analysis and it is to be hoped the results attained by him are not often paralleled. Another explanation may be that after analyzing one sample, the analyst thought that the composition of the others could be guessed at with a saving of time to himself and no increase of cost to his Sheffield patron, and that the latter may have paid an equal price each for one analysis and two guesses.

The First Steel Ever Manufactured in the Lake Superior country was turned out at the works of the Superior Iron and Steel Company, on the 27th January of the present year. On the 2d February, an interesting ceremony was performed at the same works. A steel plate was rolled, and, followed by a civic procession, was carted to a ship-yard and placed and riveted in a whaleback steamer in process of construction, the action of the citizens in organizing the procession evidently marking their satisfaction at the establishment of this new industry, probably the beginning of a growing home market for Lake Superior Ores.

An Important Investigation has, in conjunction with Mr. Ernst Schmid, been carried out by Prof. George Lunge, Ph.D., who has communicated his results to the *Engineering and Mining Journal*. The object of the investigation was to determine the action upon aluminum of liquids in common domestic use, and of such as are used in surgery, etc. A previous study of the same subject by German investigators published in a German pharmaceutical journal was adverse to the use of aluminum "for any use in which it may come in contact with liquids intended to pass into the human body." Prof. Lunge, seeing that this conclusion, if correct, was of the utmost importance as affecting the future applications of aluminum in the arts, instituted a series of experiments either to verify or disprove the results claimed by the previous experimenters.

His description of the methods employed by him shows the utmost care to avoid errors, but interesting as it is, it must be omitted here. The conclusions arrived at are, however, very reassuring, and those of more immediate importance are best given in Prof. Lunge's own words:

"From our experiments the following conclusions may be drawn: The action of coffee, tea (both of which had been poured in hot), and beer is zero or practically so; that of brandy is also extremely slight; the action of acids and acid liquids (wine, sour milk, fruit-juices, etc.) is more pronounced, but even in this case far too slight to cause any alarm whatever. Taking the worst case found, that of acetic acid, we find a maximum attack of less than 5 milligrammes per 100 square centimetres in 6 days. Now, a canteen holding a litre (or nearly a quart), has an inner surface of about 600 square centimeters and an aluminum weight of about 200 grammes. Such a canteen would in the very worst case lose 5 milligrammes in a day, even if it were always full, or 1 gramme in 200 days, and only in 55 years would it be reduced to half its weight. This is certainly too trifling a work to be practically considered. Nor is there the slightest danger of any injurious action upon the human body by such traces of aluminum compounds, seeing that our food contains very much more of these. Moreover, aluminum compounds are not poisons in the ordinary sense, to be compared to compounds of arsenic, mercury, lead, copper compounds, etc.; they cannot act injuriously unless quantities a hundred times larger than those we have found were regularly entering into the human stomach. The final conclusion must, therefore, be this: that aluminum may, without any fear, be employed for canteens or any other vessels serving for holding articles of food at least at the ordinary temperature."

Aluminum for Flash Lights, according to the *Engineering and Mining Journal* has been proposed as a substitute for magnesium by M. Villon who claims that for this use it has the advantage that an exceedingly intense light can be obtained without smoke. Aluminum powder "is mixed with chlorate of potassium and sugar, in which condition it can be ignited, giving an intense light, but is somewhat dangerous. This powder may be burned in the flame of a spirit lamp, or, if a flame of much more brilliancy is required, in a light supplied with a jet of oxygen. The light has high actinic power and may be used in photography as is the magnesium light. The most convenient way of obtaining a very intense light, according to M. Villon, is to use a lamp provided with a jet of oxygen at the center of its flame, into which powdered aluminum mixed with a quarter of its weight of lycopodium and a twentieth of its weight of nitrate of ammonium can be projected by means of a tube furnished with an air ball." This use may add another to the many industrial applications already found for aluminum. It seems, however, that the admixture of sugar could hardly result in the entire absence of smoke, since its combustion in air when mixed with chlorate of potash is generally attended with a very dense smoke (unless mixed in explosive proportions), to consume which, it would seem, a much more effective means of burning than an alcohol flame would need to be employed.

The Calorific Power of Southern Coals was made the subject of remark by Mr. Olin H. Landreth, C. E., at a recent meeting of the Engineering Association of the South, held in Nashville, Tenn. He asserted that a series of tests covering a large number of southern coals had developed the fact that there are at least three southern coals superior in calorific power to the standard second pool Pittsburgh coal, and but slightly below Cumberland, Md., semi-bituminous coal. This brought out considerable discussion, in which, however, no question of the correctness of Mr. Landreth's statements appears to have been made.

Rich Mercury Deposits are reported to have been discovered in the provinces of Ekaterinoslav and Daghestan in Southern Russia, and *Industries* (London) says that they are to be efficiently worked. That journal moreover ventures the opinion that the output of these new mines will be sufficient to effect a marked reduction in the present price of mercury.

Fifty Millions Tons of best quality Bessemer Ore are said by good authority to be in sight at a point fifty miles north of Duluth, in the Mesaba range. All accounts agree that this is one of the most remarkable deposits of iron ore in this country.

MECHANICS

AN Alleged Misapplication of Carnot's law to steam-engines in which the inducted steam is superheated after leaving the boiler, has been pointed out by Lord Rayleigh in a communication to *Nature*. In the recent treatise of Prof. Cotterill on the steam-engine, Lord Rayleigh finds an instance of this misapplication. "After explaining that in the ordinary engine the superior temperature is that of the boiler, and the inferior temperature that of the condenser," Prof. Cotterill states that "when a superheater is used the superior temperature will be that of the superheater which will not then correspond to the boiler pressure." Upon this statement Lord Rayleigh makes the following criticism:

"This statement appears to me to involve two errors, one of great importance. When the question is raised, it must surely be evident that, in consideration of the high latent heat of water, by far the greater part of the heat is received at the temperature of the boiler, and not at that of the superheater, and that of the relatively small part received in the latter stage, the effective temperature is not that of the superheater, but rather the mean between this temperature and that of the boiler. An estimate of the possible efficiency founded upon the temperature of the superheater is thus immensely too favorable. Superheating does not seem to meet with much favor in practice; and I suppose that the advantages which might attend its judicious use would be connected rather with the prevention of cylinder condensation than with an extension of the range of temperature contemplated in Carnot's rule."

This criticism does not appear to be called for by Prof. Cotterill's statement. Of course, it is that portion of the heat content of the vapor computed between the limits of superior and inferior temperature that is converted into work in a steam-engine and which measures the engine's efficiency; and though the ordinary formula as applied to saturated steam will not answer for the computation of the efficiency of an engine driven by superheated steam, this fact does not change the general principle as enunciated by Carnot that the wider the difference that can be maintained between the superior and inferior limits of temperature the greater will be the efficiency of a vapor engine. Lord Rayleigh further says:

"If we wish effectively to raise the superior limit of temperature in a vapor-engine, we must make the boiler hotter. In a steam-engine this means pressures that would soon become excessive. The only escape lies in the substitution for water of another and less volatile fluid. But, of liquids capable of distillation without change, it is not easy to find one suitable for the purpose. There is, however, another direction in which we may look. The volatility of water may be restrained by the addition of the saline matters, such as chloride of calcium or acetate of soda. In this way the boiling temperature may be raised without encountering excessive pressures, and the possible efficiency, according to Carnot, may be increased."

Now it is true that the volatility of water may be restrained by the presence therein of saline matter; but when the water is separated from the dissolved salt by the action of heat, and assumes the form of vapor, this vapor takes the pressure corresponding to its temperature as surely as though it were generated from pure water. The restraining influence upon the water in the solution does not reach to the vapor nor affect its tension, and the use of salts of any kind could in no way change the quantity of heat contained in a given weight of steam at a given temperature. If this were the case, the whole fabric of thermodynamics, so far as it relates to the pressures, temperatures, and inner and outer latent heat of vapors would be of no more value than an old wives' fable.

Of Water Gage Fittings for Steam Boilers, the *Mechanical World* (English) points out that with the high pressures now used, the breaking of the glass is not only

a frequent source of trouble, but that the flying pieces of glass, and the scattering of the hot water attending such breakage are also a frequent source of personal danger. The cause of the breakage is not the steam pressure itself, as the tubes though brittle as compared with metal tubes are capable of standing a very much higher pressure. A pressure as high as 3500 lbs. per square inch has been withstood by good Scotch glasses without fracture. The real cause is so well stated in the *Mechanical World* as to justify its quotation: "A stronger force is present under the working conditions of gage glasses on steam boilers, and the higher the pressure the greater is such action—namely, contraction and expansion, exerting a power that is capable of causing fracture even in the strongest metals, much more in the case of such a brittle substance as glass. It has always been the aim of engineers to make allowance for the expansion and contraction of metal, but in gage glasses this rule would seem to have been neglected, the only provision made being to prevent any injury to those in charge through the breakage of the gage glass." An enumeration of protective devices is given in addition to the above. Of automatic water gages 150 have been made the subject of applications for patents during the last fifteen years, of which nearly two-thirds of the number were patented; but only two have been received with any favor, namely Dewrance's and Hopkinson's. The others have failed under working conditions. Slotted brass tubes, shields of wire gauze, and other analogous devices have been used as safety appliances. These aid in preserving the glass from external cooling influences and thus, to some extent, diminish breakage; but still the breaking of a glass is a not uncommon occurrence. The writer says that "in the case of the boiler of the s. s. *Gemini* fitted with Dewrance's asbestos-packed water gage, which exploded in 1889, the engineers broke five glasses between Cardiff and the Lizard on a voyage to London. The fourth broke whilst tightening the glands. Having no more glasses, they were reduced to two test cocks. The top one of these was set fast, and the handle bent when they tried to start it. The remaining test cock was only 1½ in. above the combustion chamber top, which collapsed upon reaching the Downs, although water showed in the test cock." The fittings are often constructed and mounted improperly, and are thus caused to interfere with the normal expansion and contraction of the glass. In such cases breakage can hardly fail to result. The greatest care should be exercised when fittings are screwed into the boiler plate that they should be not only square with the boiler plate, but with each other, and thus avoid any nipping of glands or nuts upon the surface of the gage glass when tightening the glands. A steel bar turned to a true-fit in the glands is recommended as a means for testing the center lines of the mountings when fitting the latter in their places.

A New Work on the Steam Engine, in which are collated examples and results of the latest practice of the most eminent designers and successful constructors, will be welcomed by the mechanical engineers of this country, who have found the modern pace in this branch of engineering so fast that effort has been required to keep up with the procession. Such a work is that entitled "The Steam Engine," by Daniel Kinnear Clark, M. Inst. C. E., M. I. M. E., etc., from the press of Blackie & Son, Limited, London, Glasgow, Edinburgh, and 73 Bible House, Astor Place, New York City. The name of this author is so familiar to engineers through his former works, and is so favorably known in this connection, that it will be in itself an assurance of the value of the treatise. The publishers have also long held an honorable place among book-makers. The inference would be that this must be a valuable book, without an examination of its contents. Such an examination more than justifies the inference. It is impossible in the short space that can be here allotted to a notice to give the reader an adequate idea of the work. Only an outline of its contents can be attempted. The book is of super-royal octavo size, in twelve parts. In stiff paper covers the price is $1.00 for

each part. In four half-volumes bound in cloth the price is $4.00 for each half-volume, thus making the price of the entire work $12.00 or $16.00, according to the form selected. The scope of the work includes the principles and performance of steam-boilers, the principles and performance of steam-engines, the construction of steam-boilers and the construction of steam-engines, these four comprehensive sections making up the entire work and covering all varieties of boilers and engines, whether stationary, portable, locomotive or marine. Numerous modern examples of each are discussed, described and illustrated in detail. The extent to which practical details are treated is best evidenced by the statement that no less than 1300 figures have been required to illustrate the text, besides a series of large plates containing drawings to scale of typical engines, illustrative of the most advanced state of the art. The reader will find no fossilized matter in Mr. Clark's book, which, while omitting nothing that has been proved worthy to be retained, wastes no time or space in the discussion of discarded or archaic construction or practice. While thoroughly scientific, it is so practical in its treatment as to meet every want as well of the mechanic who desires merely to qualify himself for running an engine, as of the designer who wishes to acquaint himself with all the refinement to which the steam-engine has been carried.

The Heating of the Grand Trunk Railway Shops at Fort Gratiot, as described in the *Railway Master Mechanic*, has been carried out on the hot-blast system under designs of the Huyett and Smith Manufacturing Company of Detroit. The paper named gives an illustration of the apparatus employed, which is an immense iron box-coil of steam heated pipes through which a fan-blower, six feet in diameter, forces air at the rate of 60,000 cubic feet per minute. This volume of pure warmed air is discharged into one end of the large space (894,000 cubic feet) to be heated. The peculiarity of this arrangement that will strike heating experts with surprise is that it is claimed to heat all parts of the space agreeably, a result that most engineers would have considered in advance as highly improbable, if not impossible, without the assistance of conduits to convey the warmed air to distant parts of the building. The rapid rate of delivery probably accounts for the success said to have attended the installation, a volume of air sufficient to fill the entire space being introduced in about fifteen minutes. The fan blower requires about twelve horse power, and in moderate weather the heating is done entirely by exhaust steam. Both on account of the space heated and the absence of air-pipes, this example of modern heating, which from its nature must also effect very thorough ventilation, is of instructive interest to owners of large shops and manufactories, as well as to heating engineers.

Silicon and Aluminum as softeners of hard iron in foundry work were discussed by Mr. Thomas Turner, an English metallurgist, in a recent lecture, of which the *Mechanical World* prints an abstract. The practical point of value to foundrymen made by the lecturer, is that while silicon costs substantially nothing as compared with aluminum, its ameliorating effect upon hard scrap is as notable, and if anything more uniform than that of the more costly metal. "Silicon possesses the advantage, as compared with aluminum, that its use adds nothing to the cost, but not infrequently actually reduces it; silicon also is less energetic in its action, and hence much more under control. But both silicon and aluminum, when used as 'softeners,' must be regarded somewhat in the light of medicines, and used with care, for an excess of these elements may prove as injurious to the cast iron as a deficiency.'

The Use of Nickel in Alloys long before it was isolated, is spoken of by a writer in the *Mechanical World* as an anomaly in metallurgy. In the Packfong of the Chinese the metal has been in use hundreds of years. The malleability and ductility of the metal are destroyed by the presence of impurities. Occluded carbonic oxide in particular is deleterious, and it is as late as 1879 that Dr. Fleitman, of Iserlon, Prus-

sia, discovered a practicable method of removing this gas by the addition of about one-eighth of one per cent. of magnesium just previous to pouring. From this and other improvements in the metallurgy of nickel, it has now come to be one of the more important industrial metals, its uses being constantly extending. The recent use of it as an alloy in steel seems likely to revolutionize the manufacture of armor plates, and this use alone, if generally adopted, will create a demand for it greater than for all other purposes to which it has hitherto been applied. The power to resist corrosion which alloying steel with nickel imparts to it, is directing attention to the use of nickel steel for boilers; and the day may not be distant when this use will add to the ever increasing use of the metal.

A New Soap for Metal Work is also described in our chemical exchanges. The basis is cocoanut oil. Its ingredients are stated to be cocoanut oil, 2.5 kilos, chalk, 180 grms., and alum, cream of tartar, and white lead, of each 87.5 grms. The oil is melted in an iron vessel containing a little water, and the other ingredients are added in the order named, while constantly stirring the mixture. The mixture is then decanted into molds wherein it solidifies. In use, it is made into a paste with water and applied either by cotton waste or a rag. It is said this preparation has the advantage over some other preparations for the purpose that it never spoils in keeping.

A New Design for Stay-Bolts in Steam Boilers forms the subject of an illustrated description in a recent number of the *American Machinist*, which states that it was "the outcome of having to tighten leaky stay-bolts in boilers under steam pressure." The stay-bolt is cut with threads on each end as in the ordinary fashion, and has, drilled axially in each end, a tapered hole extending for some distance into the body of the bolt. Into these tapered holes are fitted soft steel plugs. The driving in of these plugs expands the end of the bolt so as to completely stop leaks, and as it can be done readily with the hammer it forms a most convenient method of tightening. All the difficulties of riveting down stay-bolts, screwed in in the manner described, are obviated by this simple and ingenious device.

An Economical Division of Motive Power is, according to the Sierra (Cal.) *Tribune*, as quoted in the new catalogue of the Pelton Water Wheel Company, coming rapidly into vogue, the various departpartments of a mill being driven by separate wheels, rendering each independent of the other, and, by a more direct application of the power, reducing the amount consumed by friction. Another advantage is, that not only less belting is required, but that the need for enormous belts for transmission of power is obviated.

The Life of Cables on Cable Tramways, has been discussed editorially in the *Street Railway Journal*, which presents in a pointed way the conditions other than mechanical that tend to limit the term of service. It estimates that an ideal cable carried idle by perfect mechanical appliances, may be expected to become worthless through crystalization alone in five years; but the amount of traffic and climatic influences tend to still further shorten the serviceable period of cables so that, according to the opinion of a street railway official quoted in the editorial referred to, "fifteen months" generally brings them to the scrap heap.

A Device for Signalling to the rear and thus preventing tail-end collisions has been recently invented. A low and light steel carriage or signal-car for attachment to the rear car of a train, and carrying the necessary signals, is adjusted so that it can be detached at once when signals to the rear are needed. It is impelled to rear by a coil-spring motor as soon as detached, and is picked up by the locomotive of the train behind and driven along to the next station, the stalled train that sent it back getting another at the first station after it is again in motion. There seems no mechanical impracticability in this device, should it so far adapt itself to modern railroad methods and management, as to justify its adoption. Most failures in inventions for railways are due to want of such adaptation.

POPULAR MISCELLANY.

THE Commercial Immorality of the Japanese has been roundly denounced by the English Consul at Hiogo. The English as a nation object to the commercial progress of any other nation, and the acquisition of commercial immorality on the part of the Japanese is an advantage which John Bull seems very reluctant to share with the orientals because it enables the latter to do almost as well in mercantile transactions as the English themselves. When a few years ago English cotton manufacturers practised shipping flimsy cotton goods to eastern markets, first loading these cloths with size to give them weight and the appearance of integrity, obeying thus St. Paul's injunction to Christians (the English are pre-eminently Christian) to "avoid even the appearance of evil," nothing much about English commercial immorality was said (by the English) till it was perceived that a permanent injury to English commerce was resulting from the practice. The immorality was then quickly discovered. It may be stated, as a general proposition, that it is immoral to obstruct in any way, whether by legal enactment, by imitation of English practices, or by competition, the accumulation of wealth in British coffers. It was, therefore, not to be expected that when these orientals adopted certain methods which they had seen successfully practiced in western commerce, such assumption would pass without protest. The British Consul has protested, and the echoes of his denunciation have reached American shores. This is what we hear about the Japanese: "When a profit is realizable, goods ordered are taken with praiseworthy promptitude, but should an engagement involve a loss, then the foreign importers are compelled to wait for that reaction which will permit of the buyers clearing their purchases with a minimum of loss to themselves." Per contra, a correspondent of *Industriès* (London), who signs himself "Oriental," says that "if the truth were fully told it would be evident that if the English merchants had not in many cases resorted to methods which were indefensible, for the purpose of advancing their own individual interests, there would have been little to complain of on the part of the Japanese. Instead, therefore, of lecturing the Japanese merchants, I would advise the British Consul to give some much-needed advice to his own countrymen, who, if their own methods were what they ought to be, could easily put a stop to any irregularities on the part of the Japanese." "The evil that you teach me I will execute," seems to be the motto of all the eastern races upon which Great Britain attempts to force her commerce. It goes hard when they "*better the instruction.*"

The Ohm-Henry Controversy which has occupied considerable space in the electrical papers, and in which the late Prof. Henry's claims have been ably championed by his daughter has brought to the public remembrance the old Albany Academy, once a prominent institution of learning in this State, and likely to become famous in history as the place in which Prof. Henry first became known as a promising young scientist, and where he made his first brilliant discoveries. The writer in former years spent many happy and profitable hours in this institution, an engraving of which, as it appeared in 1826–1832, has been used as an illustration in Miss Henry's articles. Many historical recollections cluster around this building besides those relating to Prof. Henry. It looked in 1865 precisely as it did in 1826, no alterations having been made in its exterior. At the latter period it was the home of the Albany Institute, a scientific association of which John V. L. Pruyn was then president, and including as members the principal scientific and learned men of the city conspicuous among whom were Prof. Hall, the State Geologist; Prof. Howard Townsend of the Albany Medical College; Prof. J. H. Mosher, also of the Albany Medical College; John Patterson

an eccentric mathematician of rare ability and author of an abstruse treatise entitled the Calculus of Operations, and many others who have since passed out of life. This society had among its founders De Witt Clinton, always to be remembered as the great promoter of the Erie Canal, at the time the greatest engineering feat ever attempted in this country, and as once the honored Governor of New York State. The architecture of the building was simple yet chaste and imposing, and in comparison would put to shame many more pretentious modern buildings. From its portals have issued many youths destined to take their places among the most honored of the citizens of the State, many of them to become famous in after years, in law, medicine, civil engineering and the art of statesmanship. The Albany Institute had a good library, and corresponded with other learned associations, both in this and foreign lands. For many years it published regularly its annual transactions, which contained many valuable contributions to science. On the whole, there has probably been no institution of learning in this State that has had a more profound influence upon the advancement of science in its day than this same old Albany Academy, in which Prof. Henry was taught and in which his great electrical discoveries were made.

The Successful Cultivation of the Japanese Lacquer Tree at Frankfort on the Main has led to a consideration of the possibility of transplanting to Germany the art of lacquering as practised in Japan, and to the end that the practicability of this idea may be tested, Prof. Rein, of Bonn, a famous author on the subject of Japanese arts, is giving attention to the conditions upon which success depends. The juice of this tree, *Rhus vernicifera*, is a natural varnish of very fine quality and susceptible of taking a very high polish. Since the juice of the tree, as grown at Frankfort, gives to chemical analysis results in no wise differing materially from similar analysis of the juice of the native tree, and its physical qualities also appear to be the same, Prof. Rein inclines to the belief that one reason for the universal failure in European attempts to imitate Japanese lacquer-work with imported lacquer may lie in the fact that effects attainable by using the juice freshly drawn from the tree may become impossible when the juice has stood for a considerable time before use. As a preliminary experiment, juice drawn from the trees at Frankfort has been sent to Japan to see what Japanese artists can do with it, on the supposition that the habitat of the tree may possibly exert some unknown influence upon the quality of its juice. There are now at Frankfort a number of these trees, thirty feet in height, and some of them have borne seed, from which younger trees have been grown. This has demonstrated the possibility that the tree will grow, thrive and reproduce in other climates than that of its nativity; and as it produces another valuable product besides the lacquer, a certain fatty substance called Japan wax, the tree may yet become extensively cultivated in Europe.

The Sisal Grass of Yucatan, according to a correspondent of the St. Louis *Globe-Democrat*, has industrial possibilities of great promise. He describes it as growing in long blades, sometimes four or five feet in length. In drying, these blades roll or curl up into a wisp somewhat resembling a cord in form, but said to be stronger than any cotton cord of equal size that can be manufactured. It is added that it has already a commercial demand in the manufacture of grass goods, and that ropes and cords of any size may be made of it. It is said to be very resistant to water and to decay. Nothing is said of its adaptability to paper-making, for which it would seem, from its qualities, as described, it must be well fitted. The correspondent referred to predicts that "it will, in time, prove one of the most valuable productions of Central America."

Lightning has an Affinity for Coal-Oil, is a proposition printed by the *Sewing Machine News* and copied into the *Scientific American* without comment, hence presumably approved by the latter publication. That with any approved definition of the word "affinity" so absurd a statement should start on its rounds and get an im-

pulse from a paper, whose name implies that it treats of scientific subjects and claims to be scientific, is rather remarkable. It would be just as proper to say that metals have an affinity for heat or for gravity, or even for chemical affinity itself, as to say that coal oil or any other substance has an affinity for electricity. But if it be supposed that "*attraction*" was meant, and that by an inadvertence the word "affinity" was wrongly used, the statement, so corrected, will not bear scrutiny. That coal-oil has any special attraction for electricity is not proved; and the argument by which the proposition is sought to be maintained, to wit, that coal-oil tanks are often struck by lightning, proves nothing, inasmuch as such tanks are universally made of iron through which lightning finds a path of least resistance. If on its passage it heats the iron to a temperature sufficient to ignite oil and at the same time the conditions permit oxygen from the air to sustain the combustion, the resulting conflagration is dependent in no way upon any existing attraction of the oil for the electric current. This singular misstatement might be pardoned to the *Sewing Machine News*, an excellent trade paper making no special pretension to a scientific character—but its reprint without remark in a paper claiming to be scientific is inexcusable.

The Ethnology and Archeology of Honduras are to be studied by an expedition sent out by Harvard University under the charge of Prof. F. W. Putnam. The expedition, says the *American Architect*, has reached Honduras in advance of Prof. Putnam, who will follow shortly. "Meanwhile, the little band of scientific men has reached Honduras, and has erected a camp in the court of the great pyramid of Copan. Thirty-five native laborers have been engaged for the work of excavating, and casts and photographs of the carved stones, which lie about in great numbers, are being secured as rapidly as possible. The University, or, more specifically, the Peabody Museum of Archeology and Ethnology, has been, by a decree of the Government of Honduras, placed in sole charge of all the ruins in the country for a period of ten years, with permission to excavate at discretion, and to remove half of the objects of interest secured. The condition of the grant is that the work of exploration shall be continued from year to year during the specified term, and the University will do its best to utilize its opportunity."

A New Preservative for Animal Specimens in Museums, and other collections, has been discovered, and in a communication to *Nature* its composition and mode of use are described by Mr. Haly, its discoverer. The liquid which, it is claimed, preserves both form and color more perfectly than any other substance yet tried, is a mixture of cocoa-nut oil and carbolic acid. Sufficient carbolic acid is added to the oil to raise its specific gravity to from 10° to 20° below that of proof-spirit. The most delicate and fugitive tints on frogs, snakes and fishes are thus retained. The skins of large fishes can be preserved indefinitely by packing them in this preparation and mounted at future convenience. Mr. Haly says that "these skins do not require varnishing, neither do they turn brown, but although, of course, they do not preserve their sheen like fish in the oil itself, they always maintain a silvery and natural appearance, quite different from that of ordinary museum specimens." Mr. Haly adds to the above that cocoa-nut oil, carbolic acid and turpentine mixed together make a splendid microscopic fluid in which he has kept minute specimens ten months entirely unaltered.

A Curious Dental Operation is mentioned in *Discovery*, being no less than the filling of a cavity in a tooth of an elephant in the Paris Jardin des Plantes by M. Sauverre, whose name has consequently been sounded through the French capital. It is said that his huge patient behaved very well under the painful operations, of filing, boring, excavating and malleting, only indicating his suffering occasionally by a rapid waving to and fro of his proboscis. When the operation was ended, the elephant is said to have indicated his satisfaction and gratitude by caressing the surgeon.

MACHINE-SHOP NOTES.

Conducted by Albert D. Pentz.

OILS are called "lubricating" and "cutting." Now, what does a cutting oil do for the tool? It certainly helps it. But is it conceivable that an oil can force itself forward to the extreme cutting-edge and by some mysterious power assist that edge in penetrating steel? Certainly not. All that the oil does is to lubricate that part of the tool where the metal rubs against it; principally near the cutting-edge where the chip is pushed aside, which chip is separated from the piece by the tool wedge, one side of which turns it away at an angle producing immense friction. The oil is of use to overcome that friction. Hence a cutting oil is a lubricating oil, and there is but one valuable machine-shop quality in oil, and that is lubrication.

It is hard to conceive of a test for a lubricant more trying than the friction of a chip on a tool. Is a cutting tool, therefore, the best instrument to determine the comparative values of lubricants? And is it a fact that lard oil, which perhaps is the best cutting oil, is also the best lubricant?

* * *

Not half of the practical draughtsmen in this country "size" the paper they work upon, and nearly all paper is improved by such sizing. All paper that was wet when attached lies flat on the board. The sizing of paper wets it enough to enlarge it so that the wrinkles shrink out of it in drying. Thin, well-cooked, clean glue is probably the best size. Add three measures of hot water to one of glue out of a pattern-maker's pot, and apply evenly with a soft brush. Very thin starch is a good size. Dextrine, because it can be used cold, is the most convenient and it is also a good one. Dextrine is the gum on postage stamps; druggists sell it.

All persons who draw on paper and who erase with either rubber or a knife, will find advantage in sizing; it solidifies and hardens the surface. Ink will not spread on it and a crayon line may be laid on it so fine as to be almost invisible.

* * *.

Gilderoy, Jr., was graduated at a technical school last summer and his head is full of steam. He is ambitious and industrious, and has already had a new boiler put in his father's shop. He has four kinds of indicators and takes two cards off the engine every day. Gilderoy, Jr., takes so much of the engineer's time in experimenting that help for him must be got, for the shop is not a very big one and hitherto has required no fireman. Gilderoy, Jr., has saved already a ton and a half of coal per week, and it is probable, with a person to watch the fire, that this may be increased to two and a half tons. Perhaps if the technology of Gilderoy, Jr., should consist a trifle less of steam, and more of tools and methods, there might be still a greater saving made in the father's works.

* * *

Max, the apprentice, had been caught by the superintendent in the act of making for himself a steel try-square. He probably had stolen the steel, and he certainly had stolen the time. The foreman acknowledged that he knew about it and that it had been in progress for months, so the whole affair was reported to the owner, who soon had the two criminals and the evidence of their guilt before him.

"Tom, when I was my own foreman and superintendent you were my apprentice," said he to the foreman, "and you know what I think about these things—but neither Mr. Teck nor the boy know from me yet. So you may go. But say, is your wife's health better this winter? I see you so seldom nowadays that I sometimes wonder what you look like. You're getting too fat. Better? Glad to hear it. Now, young man, what is this about the square?"

"I took the steel and made it so far."

"Did you ask any one for the steel?"

"No, sir."

"You stole it, did you? Didn't you know that it would have been given to you if you had asked for it? I expect boys to make a few tools if they deserve to. The extra care a boy takes to produce a good tool for his own use improves his workmanship, but a boy must not expect to do too much of it. What you do, do with the consent of the superintendent or your foreman, and ask for it. Now go back to your work and don't get into any sneaking or skulking ways."

"You see, Mr. Teck," the owner went on, "I was an apprentice myself and know boys. As we get them here they have only such principles and ambitions as are useful to them. When they come here we find out if men can be made out of them. Some fail and some do well. That's going to be a good square."

* * *

Mr. Small says that the man who thinks that the spindle of a drill-press has much to do with the roundness of a drilled hole should have an interview or two with the laborer who operates his oldest tool of that character; and if Dennis is away, a few words with the man who grinds drills and is careful that they are centered accurately and so that they don't drill too big holes will be of educational value.

* * *

Blunt's new manager enters with the results of three days of his own, and one day of the typewriter's, labor, on many sheets of paper.

"Mr. Blunt, I have prepared here a careful code of rules for the guidance of the works. I will be glad to have you overlook and sign them so that they may be printed and posted about the departments. They are similar to those of the Involved Engineering Co. and will, I think, cover all the ground."

"Mr. De Gree, I have governed this place for twenty years with but one rule, and that one is: '*We are here to build steam engines so that they can be sold at a profit.*' Now every man in this place knows that his job depends on his doing his best, and further he knows that if there is any breach of order, or of discipline; if any work is spoiled, or tools injured, or anything done to make a loss, that each particular case will be acted on with the interests of the concern alone in view. Every circumstance will, if necessary, be considered to do justice, because the works depend upon the men as much as the men depend upon the works. I would suggest in future, before you initiate a policy, that I may have the privilege of a consultation with you about it. In this case we will not add to the rule."

* * *

New Apprentice (frightened)—"Is the ingines busted?"

Old Hand (hardened to it)—"No! that is the voice of a thirsty, loose pulley. It asks for oil."

This dialogue is intended to attract attention to the most barbarous thing in a shop, a squealing pulley, and there are self-oiling pulleys made and sold cheaply which will run a year with one charge of oil.

* * *

Wooden pulleys are used sometimes because the varnish on them, when new, is believed to increase their adhesion or rather their tractile power. An iron pulley can easily be covered with paper; then sand-papered and varnished to get this result. Cut thick manila paper in strips as wide as the face. Cover one side with good glue, but before applying them to the pulley let them lie until the glue wets them through. The pulley must not be frosty. Give it also a good coat of glue and then apply the paper, rubbing it smooth with a cloth. Don't let the paper lap one end over another, and cut off what remains after the pulley is covered once around. Then on the first layer glue another layer precisely like it, breaking joints well. Then let it dry.

Glue sticks to iron until after it sets; then it will peel off if it can, but the shrinkage of the paper will hold it tight and the glue, fitting within every mark on the face of the pulley, adds a positive preventive to any tendency to slip. More paper may be added if thought best. Varnish to a glossy surface and see that it is

dry before belting to it. Renew varnish as often as required.

* * *

Tom is the foreman in a shop. He says that Dick is a thoughtless fellow, but that Harry, on the contrary, "has his mind on his work." Tom is not a great philosopher, but he has achieved the place he sought, and this ambition being satisfied he puts his whole soul into his work so as to retain it. Now nothing is more probable than that the phenomena of being awake is to think and that sleep is the cessation of thought. Hence, Dick and Harry each think all the time they are at work. When Tom says that Harry "has his mind on his work," he unconsciously uses a phrase that fits the place. But to say that Dick is thoughtless is untrue, for he also is awake. The trouble with Dick is that he thinks about things that do not forward his prospects. His mind was waltzing with last night's partner, when a cut ran up too far. Besides his thirst is so great that his faculties focus with greater intensity on the schooner of beer he is to have when the whistle blows, than on his lathe. If Tom will *think a little* of the management of his men as human beings in addition to their usefulness as shop hands, he might be able to convince Dick that his ambitions are false and that while pleasure is necessary to recreation, it is a poor object to live for, or to think continually about.

* * *

If a rule be required to find the whole number of teeth a milling cutter should have, use this one: If the teeth are to be one-quarter inch apart on the circumference multiply the diameter of the cutter by twelve; if five-sixteenths apart multiply by ten; if three-eighths apart, by eight; if seven-sixteenths multiply by seven, and if one-half inch, by six. This rule gives the space as stated quite as close to accuracy as is necessary for this purpose, and will save time if it is remembered.

* * *

A friend of mine is storing within himself mechanics and kneading it together with originality preparatory to producing a new engine-lathe which shall pull that much-abused tool abreast of the times. I have a suggestion for him or any other lathe-designer, and that is, put into it a spindle that is not weak in the middle part between the boxes. So that, when a long hole or other operation is being made in or on a piece, and when the tool cuts at a point that is just about as far out from the box, as the box is from the middle of the spindle, the cut will not chatter more there than at other points further out or further in.

* * *

A very wide groove in a reamer or tap may be made with a very narrow cutter. Suppose a concave groove of exact depth and of exact width be needed in any suitable object. We will say this groove must be seven-eighths of an inch wide and one half inch deep, and that the shop has but one round-nosed cutter an inch thick, one a half-inch thick and none between. Now if there be a milling machine with a swivel beneath its slide the job may easily be done and it may be repeated at one cut. Set the half-inch cutter exactly in the middle of the prospective groove and cut through about three-eighths inch deep. Now returning to the beginning end of the groove and by experimentally inclining the swivel to the cutter and by adjusting the cutter deeper, it may be set so that the required depth and width may be obtained. This job is well done on any universal milling machine that has a swivel block, and spiral grooves may thus be modified as well as straight ones.

* * *

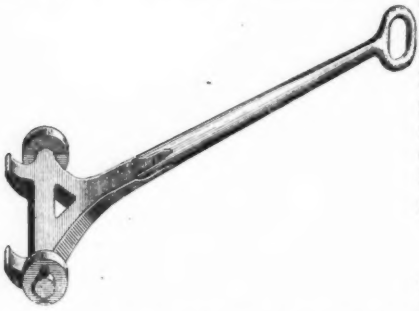
Mr. Thumb quotes the Horace Greeley remarks about college graduates with evident appreciation and ends: "And neither do I want any of the horned cattle about this place." Now, if Mr. Thumb could introduce the orderly methods which are a part of the college training into his shop it would benefit him. The question whether theoretical ignorance is better than practical ignorance is not settled yet, and if Mr. Thumb will discuss a question with as bright a college man as he himself is a practical man, he will find that there are two kinds of skill and that the "Tech"

is master of one kind. He will find also that the college man can express himself best and will if possible make the poorer reasoning appear the better.

I hope college training in engineering will be specialized so that a man who takes a course of steam engineering will be taught the practice, the theories, the mathematics, and the mechanics of steam thoroughly, and other mechanics only in such a general way as is necessary to complement this specialty. And a man who takes a course in tools in that time, will know tools thoroughly—not the tools of the text-books alone but those that do not get into text-books, as well as those that have been made since the text-books were compiled.

* * *

There is a shop in New Jersey where a tool is used that is seen nowhere else and which is neither a crow-bar nor a truck, but both. This sketch will tell its char-



acteristics, but here it is modified to handle heavier pieces than required in the shop where it is used. Two men with two of these trucks can pull a heavy casting like a lathe-bed along the floor as fast as they can walk. They are used like lever trucks, and one on each end of the object to be moved.

* * *

Brass-finishers have a tool to shape balls, which too few machinists are familiar with. It is made thus: A piece of good tool-steel half an inch round by one foot long is selected and a hole drilled into one end, five-sixteenths inch in diameter, one inch deep, and concentric with the outside. A wooden handle can be fitted on the other end or another tool made in it. The outer part of the shell around the hole is turned or ground back, on the outside, about sixty degrees, making a sharp circumference, square with the hole, and at its circular edge. Hence, because all planes cut through a ball are circles, any ball, or zone of a ball, which this cutting circumference may scrape so that its whole length lies on the surface it makes, is a true ball. This tool cuts smoother if the hole in its end be a conical one, of sixty degrees and which extend outward to the cylindrical surface of the tool; but it is more difficult to sharpen and it will fail to cut a ball where it covers one hundred and twenty degrees or more of a great circle.

* * *

Tool-makers should not be permitted to finish tools for display. If they are smooth so that they will not catch waste in the wiping of them, that is enough. The temptation to the maker of a good job to ornament it is strong, but in a few days in the factory the whole finish is spoiled. Besides, there generally is expense enough put into a tool when it is made to operate right to satisfy those who pay for it. Finish on tools, like silk-lined coats, cost more, but sooner become shabby, than do other plainer but less expensive effects.

* * *

The prepared fluid inks that are sold to take the place of the old sort of "India ink" do not seem to fill the bill. They smut as a rule—that is, they do not dry solid as the original does, and they are not so black. It is said that they are made from ivory black ground with a gum and water. Twenty-two years ago I spilled a teaspoonful of a very strong infusion of fine gunpowder tea on a newly planed cast-iron surface, this dried very soon—during the noon hour—and the resulting flakes were very black. These flakes were used as India ink and the result was so nearly like it as to be undistinguishable. Try this experiment for yourself. There are many things to indicate that this may be a pointer toward the source of this article. It is not solely a ferro-tannile.

COMMENT & CRITICISM.

Mr. Wisner's "Plan of Reform."

THE plan of reform suggested for the Government Engineering System by Mr. Wisner, in the paper published in this magazine, which I have been permitted to read in advance, is the logical sequence of the discussion which THE ENGINEERING MAGAZINE has taken up, and it is one which is deserving of careful consideration. The very elements which it is desirable to introduce as reforms are unfortunately the chief obstacles to the procurement of such results, viz., the need of divorcing the public works from politics. The features suggested in this outline are certainly desirable, and capable of a fuller elaboration. The five divisions are somewhat conflicting inasmuch as locks and dams, which are classed as special items in the fifth division, must of necessity belong also to the third and fourth. There should also be a division for irrigation and drainage works, a very important class for a large part of the public domain.

The bills now pending in Congress might readily be amended to advantage by the introduction of the suggestions by Mr. Wisner that engineers or contractors, in civil life, *should be given an opportunity* to present plans and bids for public works and take the risk of failure without having first, as now, to obtain specific consent from Congress in opposition to the Corps of United States Engineers. Under the present practice, no matter how meritorious a project may be, it is very difficult if not impossible to inaugurate it unless first approved and indorsed by the official engineering advisers of Congress, and that endorsement is generally withheld from projects originating outside of the Corps of Engineers.

While the suggestions for inaugurating this new department would seem to include both civil and military engineers, no provision is made for those military engineers for whom there may be no place and who, to-day have learned to regard the river and harbor work of the country as their special province. There manifestly should be a parallel bureau reorganized under the Secretary of War of sufficient importance to give our military branch of the Government sufficient occupation in studying foreign methods, art of war, strategy, investigations of new defensive measures, etc., to keep them fully occupied, or else the number of members in the Corps should be gradually reduced.

The most important defects of the present method of administering our public works and the remedies to be applied to meet them were set forth by the writer in a paper published in *Lippincott's Magazine* for October, 1887, wherein it was stated that there should be permanency of residence in the district under supervision, individual responsibility for results, adequacy and certainty of appropriations, and a system of promotions based upon relative ability and not on military succession. These results can be secured by dividing the country into topographical basins and assigning to each a chief engineer, whose tenure of office should be for life, subject to removal only for incompetency or misdemeanor. The first appointments should be made by the President from nominations made by the Chief of Engineers and the various engineering societies throughout the country. Subsequent appointments should be by promotions under the civil service rules from among the juniors of that residency. In this way only can a thorough knowledge of the physical, mechanical, commercial and social elements be intimately united in an efficient local executive officer. The plan of Mr. Wisner is not as yet sufficiently developed to enable a comparison of its economy to be made with the existing method, as he has not stated the number or pay of the engineers who would be required to conduct these works, but undoubtedly the introduction of competitive plans would result in greater economy and rapidity of construction.

Since the agitation was begun, it may be well to note, Congress has departed so far from its old-time precedents as to make appropriations for the full amount estimated to complete some of the more important works, as at Galveston, Sault Ste. Marie, Smith's Island, Philadelphia, etc. The subject is a very broad and important one, and deserves the most careful consideration from every point of view, and it is hoped that it will not end in discussion but in a maturely formulated system which will result in greater efficiency and economy in our public improvements. Mr. Wisner's suggestions will go far to securing so laudable a purpose.

LEWIS M. HAUPT,
Consulting Engineer.

Philadelphia, March 16, 1892.

Congress the Real Culprit.

THE Army Corps of Engineers is the only body that has had uninterrupted experience for over fifty years on river and harbor work, and during that period it has executed all the works for which the Government has made appropriations, and all the work thus done Congress directed it to do. This Corps, together with the assistant engineers now in the service, constitutes all of this country's available skill and talent, acquired by long practical experience. Time has conclusively shown the wisdom of Congress in trusting this organization, and it will certainly continue to select this faithful body for the further execution of public works.

But regarding these engineers it is claimed by Mr. George Y. Wisner that "expressions of dissatisfaction are becoming very general in regard to the management of the great enterprises entrusted to their direction."

It is singular that none of these expressions of dissatisfaction were heard at the Trans-Mississippi Congress held in New Orleans last February. The delegates represented all the States west of the Mississippi—in other words, twenty millions of people. At this congress the opening of the Southwest Pass was discussed. A few days previously a bill had been introduced in the National Congress to appropriate $8,000,000 for this purpose on the "no-cure, no-pay" plan. The author of the bill was present in New Orleans. Yet the following resolution was passed, without a single dissenting vote and amid applause, by the Trans-Mississippi Congress on February 26, 1892:

"*Resolved:* That Congress be requested to refer this [opening of the Southwest Pass] to the Mississippi River Commission of highly talented engineers of efficient ability to thoroughly investigate."

A similar resolution was passed unanimously by the Western Waterways Convention at Evansville, Ind., October 15, 1891, in the following language:

"*Third.* We again commend and approve of the plans and methods of the Mississippi and Missouri River Commissions and Government Engineers and testify to the value of the work done and the results obtained."

At the New Orleans congress a delegate from Missouri, speaking in favor of a lump sum appropriation to complete the improvements on the Mississippi and its tributaries (the amount to be determined and expended by the Mississippi River Commission and the Chief of Engineers), quoted the remarks made by General Comstock, President of the Mississippi River Commission, before the Committee on Commerce of the United States Senate, before which he had been *summoned* to report on the progress of the works and give his opinion of the merits of the Gibson bill for the improvement of the Mississippi River. General Comstock declared that no work had suffered more in the past than that of the Mississippi River, owing to insufficiency of appropriations, and that the chief merits of the Gibson bill are its provisions for continuous appropriations.

And at Evansville also the same point was emphasized in the following resolution, passed unanimously:

"*Second.* Realizing the inefficiency of the present method of irregular and uncertain biennial appropriations, and believing that with fixed and continuous appropriations the work of improvement would be more efficiently, economically, and rapidly carried out by the various River Commissions and Government Engineers, in whose charge the improvement of the rivers is

placed, we respectfully but urgently request Congress of the United States, in considering the needs of this important work, to adopt a plan of fixed and continuous appropriations to be made, until this great system of internal improvements shall have been completed."

Regarding expedition and economy the Army Engineers are in accord with Mr. Wisner. Both, however, find their remedy at the hands of the National Congress. If the Gibson bill appropriating $15,000,000, to be expended *pro rata* per year for five years, becomes a law, it will be equal, as past experience shows, to $20,000,000 appropriated under the now-and-then system. It is a change of legislative methods, not a change of engineers, that is needed. This reform is not within the province of an Army Engineer. It is a matter of legislation, and must be the work of Congress.

The Army Engineers have expended a total of $200,000,000. Mr. Wisner cites failures amounting to $13,000,000, or 6½ per cent. Can civil engineers show a better record? Why, then, do the American people demand that no bridge shall be built without approval of the plans by a Board of Army Engineers? The whole world is strewn with wrecks and failures due to ill-constructed civil works. An honest comparison of the work of the Army Engineers with that of civil engineers would establish so completely the ability, success, and fidelity of the former that even Mr. Wisner would be obliged to acknowledge the force of the evidence.

JOHN D. SCHMIDT.

New Orleans, La., March 9, 1892.

Army and Civilian Engineers.

IN the hope that a calm and methodical statement of my reasons for believing that all public works should be entrusted to those best qualified by experience for their construction, without regard to the source from which they derived their fitness, may contribute to a settlement of the controversy between army engineers and civilian engineers, and to soften the feeling of enmity which finds intemperate expression on both sides, I desire to institute a comparison between the training and incentives given to the West Point student and those offered to the civilian engineer.

When a young man is appointed a cadet at West Point by the Congressman of his district, neither his parents nor himself, as a general thing, have any idea beyond that of securing him an education by the country and a life position in the army. Four branches of the service are open to him—Engineer Corps, Artillery, Cavalry, Infantry. No matter which branch he is to enter he receives the same education and training, and his wishes are not consulted in the assignment by his superiors. He leaves West Point with a consciousness that his position in life is fixed and that in times of peace promotion is governed by seniority. He is a lieutenant and not likely to be a captain until some one dies or is retired. With ambition, zeal and labor he may make himself heard from, may receive some special recognition, may be given some valuable opportunities limited in range. But the fact remains that he gets the same pay as any other of equal rank, no matter how superior he may prove in energy and capacity. After the curriculum at West Point—chemistry, mineralogy, mathematics, physics and engineering, to each of which studies but limited time can be given—there follow three years at Willet's Point, mainly devoted to practical work in topography, harbor surveying and the testing of building materials, together with the study of certain books on harbor and river improvement.

Then the young man starts out to take charge of important public works. He finds straightway that errors in plans, errors in judgment, errors in estimates, are either condoned or overlooked; that for public works money and time are unlimited; that no close examination is made of the manner in which the money already appropriated has been expended; and that no one is held to a strict personal accountability. Plans that have cost immense sums are abandoned as failures; new plans are recommended, and new appropriations called for. When appropriations fall short the civilian assistant is retired, as the office and salary and incidental expenses of the army engineer must be maintained. Is it any wonder that under

such conditions the young man grows careless and indifferent? Incentives are lacking to make him accurate, sure, economical, and expeditious. Though now and then an exceptional man may prove unsusceptible to these influences, such surroundings necessarily have their insidious effects upon ordinary people.

The civilian engineer, on the contrary, after graduating at some prominent institution, having no life position assured him and dependent on himself alone, pursues a course looking to engineering in its fullest and broadest extent, both theoretical and practical. His reputation has to be made in hard, practical work before he even properly acquires the title of engineer. He soon learns that accuracy, certainty, economy and celerity open the only way to promotion. He becomes fully conscious of his own individual accountability. He perceives that even a trifling blunder means loss of position and increased difficulty in securing another. And if he estimates that it will require $1,000,000 and two years' time to complete a given work, and the event shows that $2,000,000 and four years' time were the real need, his reputation and hopes are blasted. The capitalist will not forgive in the civilian engineer what the Government overlooks in the army engineer. The tendency of such responsibility is to develop the highest order of manhood and the highest quality of work.

The standard of excellence in all important structures can be expressed in the following words: strength, durability, fitness, and, consistent with these qualities, completion in the least possible time and at the least possible cost. Onerous, useless requirements in the contract and specifications, and a ruthlessly strict adherence to such terms and conditions, increase immensely the cost of structures as well as the time necessary for completing them; and these, coupled with terms of payment agreed upon, prevent many good contractors from bidding on Government works. It seems evident, then, that civilian engineers are qualified to do work at less cost and in less time than the army engineers require. Moreover, the strict military relations existing between officers of the army corps tend to dwarf rather than develop in their subordinates that freedom and originality of thought and action which conduce to the best results.

Do not these considerations justify the following conclusions:

1. Civilian engineers, as a rule, enter upon the practice of their profession better equipped than the United States Engineers.

2. All the conditions surrounding the civilian engineer are incentives to the attainment of the knowledge and characteristics essential to the greatest usefulness and eminence in his profession, whereas the conditions surrounding the United States Engineer have an opposite tendency.

3. Works of like grade can generally be executed by the civilian engineer at less cost and in less time.

4. United States Engineers are frequently put in charge of certain kinds of work in which they have had little or no experience, simply because they belong to the Engineer Corps.

5. The field of the civilian engineer necessarily embraces a broader range, and consequently produces a higher order of mental development.

If these positions are sound, it obviously follows that the Army Engineer should not have the entire control of our public works.

W. M. PATTON, C. E.

Lexington, Va., February 8, 1892.

Mismanagement of Public Works.

THE evils connected with the management of public works in the United States are largely due to the fact that it is entrusted to the Corps of Military Engineers, a body originally organized simply to build forts and Government roads and bridges for army use during the war. The West Point education of its members, while covering a little civil engineering and a good deal of mathematics, would not carry a student beyond the sophomore class in any modern technical college. Their experience is acquired at the expense of the Government, the Chief of the Corps assign-

ing his subordinates in rotation to various Government posts, each requiring knowledge of a special branch of civil engineering.

The blunders that ensue are very costly, often involving the waste of a million dollars in a single case. At Galveston Harbor the cost to the Government is already $2,000,000, and the end is not yet. At Manasquan Inlet, N. J., where the experiments have cost $52,000, Congress has had to appropriate $2000 to pull up the jetties built and remove them. The Government has spent over $3,000,000 in building jetties and wing dams on the Cumberland and Tennessee rivers, and now it is proposed to take these dams up and build the canals which should have been constructed at first.

The Muscle Shoals Canal, which has just been completed at a cost of over $20,000,000, was given a depth of only five feet on the water sills. This has been found to be too little and the locks too small for the traffic, and a board of Army Engineers have recommended that the locks be torn up and new and larger ones built. Each lock has cost $2,000,000.

They do these things better in China. The Mandarin entrusted with the regulation of the Yellow River is held responsible with his head, and, when recently the river broke through its banks, the Emperor promptly sent for this Mandarin and cut off his head. The engineering of public works is not a popular function in China. A similar policy here would cause a fearful mortality among our army engineers.

At Barnegat Inlet the light-house was located on a point which a few months' observation showed to be rapidly wearing away. The structure was destroyed, and another built on the *same point*, which is now about to go. Any experienced engineer would have placed the light, at the start, on the other side of the inlet, where the point is growing larger all the time. Similar instances might be cited at Delaware Breakwater, Brazos River and many other places.

Undoubtedly the Army Engineers do as well as they know how; the blame should attach mainly to the system which entrusts the building of such tunnels as the Water-Works Tunnel in Washington to men educated to build forts and improvise bridges. I know a lieutenant who was charged with building harbor works costing $1,800,000 when he was fresh from West Point and had never been connected with works of any kind. I know a captain who was placed in charge of river and harbor works costing over $2,600,000, though he had been only a professor at West Point and an officer in the battalion of engineers at Willet's Point, where his duty consisted in drilling raw recruits in the use of the spade and axe and handling torpedoes. Another officer, now entrusted with the building of a Government railroad, has never been connected with any railroad and has no practical knowledge of the work. Still another, a lieutenant-colonel, told me that, when he was given the construction of an important Government canal, he "knew nothing about it and had never had any experience with canal work, but had learned a good deal since!" Yes, in a school expensive for the tax-payers. And, worse still, even this costly experience too often goes for nothing. They go on building Government canals too small, when an additional expenditure of perhaps five per cent. would build deeper and larger locks to which the canal could be excavated at any time.

As long as our public works are entrusted to the conservative instincts of a West Point aristocracy these things will continue. In these works there are now about one hundred West Point army officers of the Engineer Corps and over a thousand civil engineers serving as assistants. If it were not for these civilian assistants, their lords of the army would be unable to make even an intelligent report. The assistant lays out the work, prepares the project, makes the computations, and then humbly places his plan before his superiors. Three or four of them, called in military parlance a "Board of Engineers," get together, some one of whom proposes changes which are adopted, and thus the helpless Government is committed to a plan outraging all principles of engineering science. This was the case at Galveston, where the assistant,

a well-known civil engineer, prepared a feasible plan for improvement, which was thrown aside in favor of another that failed completely after an expenditure of $200,000. When the plan of the assistant is accepted, his report is copied by the officer in charge, who takes all the credit to himself. "Ye page slew ye boar, and ye knighte had ye glorie."

As a result of this system these situations, the most important in the service of the Government, are mainly filled by foreigners, more servile than Americans, or by relatives of army officers. In one office I could mention the principal assistant, two other assistants, and the chief draughtsman were Prussians. On one of the Southern Harbor constructions one inspector was an Austrian, one a Swede, one a Norwegian, and an assistant engineer was an Englishman. In another office the chief draughtsman was a Russian, the principal assistant engineer a Canadian, and another assistant engineer who had only a mercantile education, a brother of the army officer in charge. Dozens of other cases might be cited. And how is the assistant treated socially? He is not recognized by his chief unless he happens to be a descendant of some West Pointer. In that case he is taken in as one of the family. I have heard these *gentlemen* boast that they do not know their assistants out of the office, and many require them all to make a semi-military salute to their superior officer when he enters their presence.

A word, in conclusion, as to some official perquisites. The late General Gilmore was allowed to take his station in New York, when his work lay entirely in Carolina, Georgia and Florida. He made a trip to these States once a year! I know several officers whose stations are ostensibly at their works, but who are almost never found there. We all remember how often Major Lydecker visited his tunnel in Washington. I can point to half a dozen other officers who, instead of remaining at their posts, live at the nearest watering-place, making only weekly or less frequent visits to the scene of operations, while the work is carried on by the principal assistant engineer and the chief clerk. But they have "a method in their madness." By ordering some dredge-boat or steam-launch to the neighborhood of the watering-place for repairs, they provide themselves with an excuse for leaving their station to superintend the repairs. I have known an officer to increase his salary by $125 a month by travel to and from a watering-place as they are allowed eight cents a mile and always have a pass from the railroad. The granting of passes by the railroads to officers acting as arbitrators between the roads and the Government in the matter of every bridge built over a navigable stream is plainly a violation of the Inter-State Commerce law and should be stopped.

American citizens want light on these dark subjects, and they are entitled to it.

VOX POPULI.

New York, February 8, 1892.

The Care of Roads.

A GOOD deal is said concerning the care of roads in this country; but does it ever occur to anybody that there are few if any roads to take care of? I don't call a little bit of broken stone, laid on soft mud and mashed smooth by a roller, a road. A road consists of a bed and a surface; and about the best that we have been able to do in the way of road-making is to put a road with a surface upon ordinary unprepared earth. One time I was called upon to go over the line of the little railway that runs from Brooklyn to Coney Island, and rectify matters generally. After making a tour of inspection I was asked concerning a certain curve by the old church. "Curve?" said I; "I didn't see any curve by any old church." "Why yes, there's quite some of a curve there; in fact, the sharpest one on the whole line." "Oh, I know now where you mean; I remember turning a *corner* at the old church; but I don't remember any curve." Suppose that we stop talking about taking care of our roads, and get to talking about how to make a road that shall be a road instead of only a road outline.

G. R.

Brooklyn, N. Y., February 1, 1892.

EDITOR'S EXCHANGE TABLE.

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The tabulated list of periodicals prefacing the index proper contains only those most frequently quoted. The abbreviations used in the index may be identified by reference to the table. With each article is given its approximate length in number of words.

A A.....American Architect. *w.* $6 per year. Boston.
A J R A..American Journal of Railway Appliances. *m.* $2 per year. New York.
A M.....American Machinist. *w.* $3 per year. New York.
A P B....Anthony's Photographic Bulletin. *s-m.* $3 per year. New York.
A R.....Architectural Record. *q.* $1 per year. New York.
A & B....Architecture and Building. *w.* $6 per year. New York.
B J C....Boston Journal of Commerce. *w.* $3 per year. Boston.
C E N....Canadian Electrical News. Toronto.
C E. .....Colliery Engineer. *m.* $2 per year. Scranton, Pa.
E E L....Electrical Engineer. *w.* 17*s.* 4*d.* per year, post-paid. London.
E E N Y..Electrical Engineer. *w.* $3 per year. New York.
E R L....Electrical Review. *w.* 21*s.* 8*d.* per year, post-paid. London.
E R N Y..Electrical Review. *w.* $3 per year. New York.
E W.....Electrical World. *w.* $3 per year. New York.
El.. .....Electrician. *w.* 24*s.* per year, post-paid. London.
E L.....Electricity. *w.* 6*s.* 6*d.* per year, post-paid. London.
E.....Engineering. *w.* 36*s.* per year, post-paid. London.
E M J....Engineering and Mining Journal. *w.* $4 per year. New York.
E N.....Engineering News. *w.* $5 per year. New York.
I E.....Indian Engineering. *w.* Rs. 18 per year, postage extra. Calcutta.
I L. .....Industries. *w.* 32*s.* per year, post-paid. London.
I J M S...International Journal of Microscopy and Natural Science. *m.* London.
Inv.....Invention. *w.* 28*s* per year, post-paid. London.
J A E S ..Journal of the Association of Engineering Societies. *m.* $3 per year. Chicago.
J F I.....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
J N E W..Journal of the New England Waterworks Association. *q.* $3 per year. New London, Conn.
J S A.....Journal of the Society of Arts. *w.* London.
L E.....Locomotive Engineering. *m.* $2 per year. New York.
Misc.....Miscellaneous.
N B .. ...National Builder. *m.* $3 per year. Chicago.
N .....Nature. *w.* 30*s.* 6*d.* per year, post-paid. London.
P T.. ....Photographic Times. *w.* $5 per year. New York.
P S.....Power-Steam. *m.* $1 per year. New York.
P A .....Progressive Age. *w.* $3 per year. New York.
R A E J..Railroad and Engineering Journal. *m.* $3 per year. New York.
R G .....Railroad Gazette. *w.* $4.20 per year. New York.
R A.....Railway Age. *w.* $4 per year. Chicago.
R M M...Railway Master Mechanic. *m.* $1 per year. Chicago.
R R .....Railway Review. *w.* $4 per year. Chicago.
S... .....Stone. *m.* $2 per year. Indianapolis, Ind.
Sc.....Science. *w.* $3.50 per year. New York.
T A I E E.Transactions of the American Institute of Electrical Engineers. *m.* $5 per year. New York.
W E.....Western Electrician. *w.* $3 per year. Chicago.

ARCHITECTURE.

2284. Defective Building Laws. Editorial (A A–Feb 20.) 2000 words.

2285. Construction. II. Illustrated. M. Viollet-le-Duc. (A A–Feb 20.) 3900 words.

*2318. Convention of Ontario Association of Architects. (C A B–Feb.) 15,000 words.

2386. Capitals. I. Illustrated. Adrien Joigny. (A A–Feb 27.) 4300 words.

2387. Construction. III. Illustrated. M. Viollet-le-Duc (Ibid.) 2300 words.

2388. Where to See Domestic Work in England. Maurice B. Adams (Ibid.) 3500 words.

2435. A Glance at the History of Italian Renaissance Architecture. I. Illustrated. Charles T. Mathews (A & B–Feb 27.) 1600 words.

2436. The Art of Planning. J. Mac Vicar Anderson (Ibid.) 3400 words.

2456. The Homes of Queen Elizabeth's Courtiers. H. B. Bare (A E–Feb.) 1000 words.

2474. Design of Technical Schools and Colleges. Prof. Garnett (A & B–Feb 20.) 4100 words.

*2532. Architectural Aberrations. II. Illustrated. (A R–Jan.) 1600 words.

*2533. The Battle of the Styles. I. Illustrated. A. D. F. Hamlin (Ibid.) 5200 words.

*2534. Modern Architecture. A conversation.

Illustrated. Harry W. Desmond (Ibid.) 1400 words.

*2535. An Appeal to Cæsar. C. Francis Osborne (Ibid.) 1800 words.

*2536. A Modern Cathedral. Illustrated. R. W. Gibson (Ibid.) 3000 words.

*2537. Architecture as a Fine Art. Illustrated. Wm. Nelson Black (Ibid.) 6200 words.

*2538. Colonial Annapolis. Illustrated. T. Henry Randall (Ibid.) 8800 words.

*2539. Byzantine Architecture. III. Illustrated. Prof. Aitchison (Ibid.) 8200 words.

2606. The Middle Renaissance in Italy. II. Illustrated. Charles T. Mathews (A & B–March 5.) 2400 words.

2609. Foundations and Floors for the Buildings of the World's Columbian Exposition. Illustrated. A. Gottlieb (E N–March 5.) 3600 words.

2620. Capitals. II. Illustrated. Adrien Joigny (A A–March 5.) 2900 words.

2621. Construction. IV. Illustrated. M. Viollet-le-Duc (Ibid.) 2200 words.

†2657. The Compensation of Architects. Robert D. Andrews (Misc.) 4500 words.

†2658. American Architecture. Editorial (Misc.) 1150 words.

†2659. Color in Architecture. Editorial (Misc.) 950 words.

2683. Dogmatism and Criticism. Editorial (A & B–March 12.) 500 words.

2684. Fashions in Architecture and Its Kindred Arts. N. H. J. Westlake (Ibid.) 2300 words.

2685. Saracenic Architecture. I. Prof. Aitchinson (Ibid.) 3000 words.

2688. Capitals. III. Illustrated. Adrien Joigny (A A–March 12.) 4000 words.

2690. English Bye-Ways. Shrewsbury. Illustrated. Edward Hurst Brown (Ibid.) 3100 words.

2691. Brunelleschi's Aid to Italian Architecture. G. (Ibid.) 1800 words.

CHEMISTRY.

†2335. Notes on the Technology of Rubber Pigments. W. Lascelles-Scott (Misc.) 2200 words.

2372. Arsenical Poisoning from Domestic Fabrics. George S. Hale (Sc.–Feb 19.) 600 words.

2373. Action of Microphytes on Solid Compounds of Arsenic. B. Gosis (Ibid.) 1800 words.

*2382. Contributions to the Analysis of Fats—Sperm Oil, Wool Fat, Chloresterol. Dr. Lewkowitsch. (I L–Feb 12.) 1400 words.

*2399. An Introduction to Qualitative Chemical Analysis. I. Illustrated. Barker North. (E E L–Feb 12.) 2300 words.

2458. The Methods of Pharmacology. John J. Abel (Misc.) 5200 words.

*2502. Combustion. M. E. Wells (L E–March.) 900 words.

*2510. The Commercial Manufacture of Oxygen. Illustrated (Misc.) 1750 words.

*2530. Common Salt and Its Electric Decompositions. "Electrical Engineer" (E–Feb 19.) 1300 words.

†2591. Analysis of "Eggio? A Preparation of the Yolk of Eggs. Chas. S. Boyer (J F I–March.) 700 words.

*2631. The Commercial Electrolysis of Salt. S. Rideal and James Swinburne (I L–Feb 26.) 1100 words.

*2753. The Soluble and Resinoid Constituents of Bituminous Coal. Watson Smith (I L–March 4.) 3100 words.

*2754. The Commercial Electrolysis of Salt. II. S. Rideal and James Swinburne (Ibid.) 1450 words.

CIVIL ENGINEERING.

2330. For Improved Waterways. Editorial (Misc.) 1600 words.

2332. Road Improvement. Editorial (Misc.) 850 words.

*2345. A Short History of Bridge Building. Illustrated. C. R. Manners (E–Feb 12.) 1300 words.

2366. Bridge Details. E. Swenason (R G–Feb 26.) 3900 words.

*2383. French Roads, Their Administration, Construction and Maintenance. Illustrated. Frank H. Neff (J A E S–Jan) 7000 words.

*2406. The Water Route from Chicago to the Ocean. Illustrated. Charles C. Rogers (S M–March) 12,000 words.

†2412. An Industrial Revolution by Good Roads. A. A. Pope (F–March.) 2200 words.

2429. German Practice as to Computing Bridge Strains. Illustrated. (E N–Feb 27.) 600 words.

2430. Roadmaking in Amoy, China. (Ibid.) 600 words.

2434. The Reno System of Tunneling for Rapid Transit. Illustrated. J. W. Reno (E N–Feb 27.) 1900 words.

†2442. The Present State of the Panama Canal. Illustrated. Rear-Admiral E. H. Seymour (Misc.) 8900 words.

2452. Asphalt Pavements. Julius Schubert, Louis H. Gibson (Misc.) 2600 words.

2453. Specifications for Bridges (Misc.) 4000 words.

2454. Good and Bad Roads. Isaac B. Potter (Misc.) 800 words.

2455. Paving Brick. George H. Brown (Misc.) 6000 words.

*2512. Successful Experiment in Sewage Irrigation at Crieff. (Inv–Feb 20.) 650 words.

*2523. A Short History of Bridge Building. II. Illustrated. C. R. Manners (E–Feb 19.) 2500 words.

*2565. The Palatine Bridge at Rome. Illustrated. Pietro Bonato (R A E–March.) 1250 words.

*2566. Engineering for Lumbermen. A. J. Teed (Ibid.) 2500 words.

†2578. Soft Steel in Bridges. Illustrated. F. H. Lewis (Misc.) 20,000 words.

†2588. Proposed Ship Canal Between New York and Philadelphia connecting the Delaware and Raritan Rivers. Illustrated. Lewis M. Haupt (J F I–March.) 1200 words.

†2590. Philadelphia as a Seaport. I. F. A. Mahan (Ibid.) 6500 words.

*2632. Harbors on the Pacific Coast. I. Otto Von Geldern (Misc.) 4000 words.

†2633. The Improvement of the Channels at the Entrance to the Harbor of New York. Illustrated. Joseph Edwards (T C E–Dec.) 1700 words.

†2636. Experimental Determination of the Rolling Friction in Operating the Draw of the Thames River Bridge, Together with Method for Determining Power to Operate Draw-Bridges. Alfred P. Boller, Jr. and H. J. Schumacher (T C E–Dec.) 8700 words.

†2637. Red Rock Cantilever Bridge Foundations. Illustrated. S. M. Rowe (T C E–Dec.) 15,000 words.

†2638. Red Rock Bridge. General Specifications and Proportions. Illustrated. S. W. Robinson (T C E–Dec.) 3100 words.

†2639. Red Rock Bridge. Superstructure. Illustrated. Henry H. Quimby (T C E–Dec.) 2800 words.

*2649. A Short History of Bridge Building. III. Illustrated. C. R. Manners (E–Feb 26.) 1400 words.

†2656. The Selection of Sources of Water Supply. Illustrated. Frederic P. Stearns (J N E W–March.) 21,000 words.

2692. The Civil Engineers and the Public Works of the United States. R. W. Raymond (E M J–March 12.) 850 words.

2701. The Madison Street Bridge, Chicago. Illustrated. (R G–March 11.) 1300 words.

*2740. A Short History of Bridge Building. IV. C. R. Manners (E–March 4.) 1150 words.

ELECTRICITY.

2270. Is Electricity Related to Nervous Force? J. J. Carty (E R N Y–Feb 20.) 1700 words.

2271. The Storage Battery. William Bracken (Ibid.) 900 words.

2272. Ten Years with the Telephone. John A. Barrett (Ibid.) 2700 words.

2273. The Problem of Trans-Atlantic Telephony Solved. Germanicus (Ibid.) 1200 words.

2274. The Telegraph in America. Geo. C. Maynard (Ibid.) 2300 words.

2275. Footprints of a Decade. Progress in electric lighting, power transmission, etc. (Ibid.) 4500 words.

2276. The Law of Hysteresis. Part III. Charles Proteus Steinmetz. (W E–Feb 13.) 3000 words.

2277. Compound Engines and Electric Light Stations. Editorial (E E N Y–Feb 24.) 600 words.

2278. The Manufacture of Fine Electrical Instruments in America. Illustrated. Jos. Wetzler (Ibid.) 6500 words.

2279. Further Experiments with Condenser, Spark and Air Jet. Illustrated. Elihu Thompson (Ibid.) 1100 words.

2280. A Proposed System of Alternating Direct Current Transformation. Illustrated. F. Jarvis Patten (Ibid.) 600 words.

2281. Electricity in a Modern Residence. H. Ward Leonard (E R N Y–Feb 27.) 1750 words.

2282. Competition in the Electrical Business. Editorial (E R N Y–Feb 27.) 550 words.

2291. Building and Care of Dynamos (Misc.) 1100 words.

2292. Incandescent Wiring. Thomas R. Taltavall (Misc.) 1050 words.

2301. What are We Going to Do with Our Wires? Illustrated. Nelson W. Perry (E C–Feb 24.) 2500 words.

2302. Notes on Electromagnetic Machinery. II. Illustrated. Wm. S. Aldrich (E W–Feb 27.) 1800 words.

2303. A Practical Electrical Library and Reading Room for Central Stations. Illustrated. E. R. Weeks (Ibid.) 1300 words.

2304. How the Electric Light Association may be Made More Beneficial to Central Station Men (Ibid.) 2100 words.

2305. A Proposed Amalgamation of the National Electric Light Association and the Association of Edison Illuminating Companies (Ibid.) 1800 words.

2306. The Organization and Proposed Work of the Canadian Electrical Association. J. J. Wright (Ibid.) 1200 words.

2307. On the Relation Between Rise of Temperature and Current in Electric Conductors. I. F. L. O. Wadsworth (Ibid.) 1700 words.

2309. Famous Electricians and the World's Fair (W E–Feb 27.) 3000 words.

*2338. Vulcanite as an Insulating Material. Eugen Muller. Translated from Elektrotechnische Zeitschrift (E L–Feb 12.) 1700 words.

*2339. On the Life of Incandescent Lamps. Editorial (E R L–Feb 12.) 1500 words.

*2340. Electricity and Aeronautics (Ibid.) 1000 words.

*2341. Communication with Rock Lighthouses. Illustrated (Ibid.) 1000 words.

*2342. The Developments of Electrical Distribution. Prof. Forbes (E R L–Feb 12.) 2700 words.

*2343. Gas and Electric Light. John C. Gill (E R L–Feb 12.) 1600 words.

*2344. Electric Organ Control. A. E. Conti (E R L–Feb 12.) 750 words.

*2377. Coast Communication. Editorial (E–Feb 12.) 1050 words.

*2378. Notes on Submarine Cable Work. I. H. D. Wilkinson (Ibid.) 2900 words.

*2381. The Manufacture of Phosphorus by the Aid of Electricity. Illustrated (I L–Feb 12.) 900 words.

*2385. "The Lamp," The "Electric Light Station Manager," and the "Customer." Illustrated. E. P. Roberts (J A E S–Jan.) 3600 words.

*2398. Mr. Tesla and Vibratory Currents. Editorial (E E L–Feb 12.) 2100 words.

*2400. A Description and Comparison of the Methods of Electric Lighting At Present in Use in London. I. Alexander B. W. Kennedy (Ibid.) 3600 words.

*2414. Mr. Tesla's Lectures on Alternate Currents of High Potential and Frequency (N–Feb 11.) 2600 words.

2418. Armature Resistance. James F. Hobart (P S–Feb.) 750 words.

2419. Notes on Polyphase Currents and Rotary-Field Motors (Ibid.) 1400 words.

2447. Induction by High Potential Discharges. Illustrated. Elihu Thomson (E W–Feb 20.) 2600 words.

2448. Proposed High Speed Electric Railway from Chicago to St. Louis. Illustrated (Ibid.) 1600 words.

2449. Two Proposed Methods of Transmitting Power from Niagara Falls to Chicago. Illustrated. F. C. Perkins (Ibid.) 3000 words.

2450. Utilization of Exhaust Steam from Central Electric Lighting Stations. Illustrated. (Ibid.) 1700 words.

†2461. Some Possibilities of Electricity. William Crookes (Misc.) 3900 words.

2464. Reminiscences of Early Days. Elihu Thomson (Misc.) 1250 words.

2465. What is the Back Stroke? Thomas R. Taltavall (Misc.) 900 words.

*2485. Power Plants for Electric Street Railways. Illustrated. J. H. Bickford (Misc.) 2000 words.

*2492. Electrical Communication on the Coasts of the United Kingdom. Illustrated. Robert Bayly (E L–Feb 19.) 2800 words.

*2507. Electric Tramways on the Overhead or Trolley Wire System. W. Gibson Carey E E L–Feb 19.) 2100 words.

*2508. Some Experimental Investigations of Alternate Currents. I. Alexander Siemens (Ibid.) 2800 words.

*2511. Efficiency and Cost of Electric Light. John C. Gill (Inv.–Feb 20.) 1200 words.

*2515. Views of Ether Waves and Their Action. S. Tolver Preston (El–Feb 19.) 1550 words.

*2516. Notes on Submarine Cable Work. II. Illustrated. H. D. Wilkinson (El–Feb 19.) 1500 words.

2517. The Electrical Atom. William Crookes (Misc.) 1550 words.

*2518. Electro-Capillary Phenomena and Differences of Potential on Contact (E R L–Feb 19.) 1000 words.

*2519. Magnetic Rotation and the Dissociation Theory (Ibid.) 500 words.

*2520. New Mode of Employment of Continuous Current Transformers. Illustrated (Ibid.) 1100 words.

*2522. Protection from Lightning. Alfred Hands (Ibid.) 2400 words.

2540. Precautions to be Observed in Applying Corrections to Wattmeter Readings. Ernst Danielson (E W–March 5.) 2100 words.

2541. Power Transmission. Illustrated. Wm. M. Schlesinger (Ibid.) 3000 words.

2544. Alternate Current Motors. Illustrated. William Stanley, Jr. (Ibid.) 6700 words.

2545. Overhead Construction. Illustrated. E. F. Peck (Ibid.) 3600 words.

2546. The Construction, Safety, and Operation of Switchboards. M. C. Sullivan (Ibid.) 1900 words.

2547. The Relation of Size and Efficiency in Transformers. L. B. Stillwell (Ibid.) 3000 words.

2548. Transmission of Power with Special Reference to the Frankfort Plan. Carl Hering (Ibid.) 13,000 words.

2549. Underground Construction of the Buffalo Railway Company. J. B. Craven (Ibid.) 1250 words.

2550. The Operation of High Tension Currents Underground from a Physical and Financial Standpoint. E. A. Leslie (Ibid.) 5900 words.

2551. Underground Conduits and Wires. M. J. Francisco (Ibid.) 3000 words.

2552. Electric Lighting from a Financial Standpoint. Erastus Wiman (E W–March 5.) 4300 words.

2553. From the Tannery to the Dynamo. Illustrated. Chas. A. Schieren (E E N Y–March 2.) 2900 words.

*2554. Electrodynamic Theories and the Electromagnetic Theory of Light. A. Gray (N–Feb 18.) 7400 words.

†2575. Electrical Transmission of Power. A. Saunders Morris (Misc.) 2000 words.

†2576. Electrical Transmission from Lauffen to Frankfort. Coleman Sellers (Misc.) 900 words.

*2581. Some Electrical Experiments. Chas. G. Armstrong (Misc.) 2400 words.

2587. The Allied Powers, Steam and Electricity. D. Ashworth (W E–March 5.) 3900 words.

†2592. An Early Conception of the Magnetic Field. Edwin J. Houston (J F I–March.) 2400 words.

†2593. Notes on Electro-Magnetic Machinery. Illustrated. Wm. S. Aldrich (Ibid.) 6200 words.

2599. The Measurement of Electrical Resistance. Illustrated. H. N. Bauer (P S–March.) 1500 words.

*2623. Management of Telephones in England. Editorial (E L–Feb 26.) 1200 words.

*2624. Electrical Phenomena in the Atmosphere and Their Probable Causes. Editorial (Ibid.) 700 words.

*2625. Elementary Ironless Dynamo. S. Tolver Preston (El–Feb 26.) 675 words.

*2626. Telephone Reform. Editorial (Ibid.) 1600 words.

*2627. On a Differential Electrostatic

Method of Measuring High Electrical Resistances. Illustrated. Major Cardew (Ibid.) 1300 words.

*2628. The London Telephone Service (Ibid.) 8300 words.

2661. The Ries Regulating Lamp Sockets. Wm. J. Hammer (E E N Y–March 9.) 1800 words.

2663. Electric Lighting on the Urania Theatre Stage. Illustrated. (Ibid.) 700 words.

2664. The Gas Battery as an Accumulator. W. M. Stive (Ibid.) 1050 words.

2665. A Comparative Test of High and Low Speed Engines in Railway Work. Chas. W. Wason (Ibid.) 650 words.

2666. The Protection of Light. Electric Lighting of Buoys in New York Harbor. Illustrated. (E R N Y–March 12.) 3900 words.

2667. Primary Batteries. A. O. Tate (Misc.) 1950 words.

2668. Power Transmission from Niagara Falls to Buffalo. Editorial (E W–March 12.) 2100 words.

2669. Recent Improvements in the d'Arsonval Galvanometer. Illustrated. W. E. Ayrton (Ibid.) 3200 words.

2670. On the Relation Between Rise of Temperature and Current in Electric Conductors. II. F. L. O. Wadsworth (Ibid.) 2500 words.

2671. Electrical Welding as Used in the Wire Industry. Albert M. Bullard (Ibid.) 1350 words.

2672. Standard Time. How We Get It. Illustrated. W. R. Lefroy Hamilton (E C–March 9.) 2050 words.

2673. False Economy in Station Management. A. B. Johnson (Ibid.) 850 words.

2686. Domestic Electric Lighting. Max Clarke (A & B–March 12.) 700 words.

*2733. Design and Construction of Dynamos. Illustrated. T. Rooke (F E L–March 4.) 4300 words.

*2734. The Cost of Supplying Electricity. Editorial (E R L–March 4.) 1200 words.

*2735. The Specification of Electric Light Cables. Editorial (Ibid.) 1100 words.

*2736. The Electric Light at Budapest (Ibid.) 1600 words.

*2737. A Phase in the "Dissociation" Controversy (Ibid.) 1000 words.

*2745. Hertz Oscillations. A. Perot (El–March 4.) 900 words.

*2747. Observations of Atmospheric Electricity from a Captive Balloon. E. Semmola (Ibid.) 550 words.

*2748. Electric Light Cables. J. Leslie Fuller (Ibid.) 650 words.

*2756. The Supply of Electricity for Towns. Illustrated. J. D. F. Andrews (E L–March 4.) 1250 words.

GAS ENGINEERING.

*2349. Gas Engine Economy. Illustrated. Editorial (E–Feb 12.) 1750 words.

*2357. Gas Engines for Electric Lighting Stations. Illustrated. W. W. Tonkin (Ibid.) 900 words.

*2369. Modern Gas Engines. W. Norris (Inv–Feb 13.) 1000 words.

HYDRAULICS.

2319. The Value of a Water Power. Chas. T. Main (A M–Feb 25.) 1600 words.

*2347. Birmingham Hydraulic Supply Station. I. Illustrated. J. W. Gray (E–Feb 12.) 900 words.

*2352. Motive Power Supply at Liverpool. Joseph Parry (Ibid.) 4600 words.

2432. The Chicago Water Supply and Typhoid Fever. Editorial (E N–Feb 27.) 1100 words.

2473. St. Augustine's Artesian Water. Illustrated. William Kennish (E N–Feb 20.) 2500 words.

*2524. Utilization of Niagara Falls: Scheme by Messrs. Ganz. Illustrated. Bela Szuts (E–Feb 19.) 2000 words.

*2531. The Hydraulic Machinery of Swing Bridges. T. Claxton Fiddler (E–Feb 19.) 4900 words.

2662. A Few Figures on Utilizing Niagara. Editorial (E E N Y–March 9.) 800 words.

LANDSCAPE ENGINEERING.

*2407. Small Country Places. Illustrated. Samuel Parsons, Jr. (S M–March.) 7000 words.

MARINE ENGINEERING.

*2262. Rebuilding the Navy. Illustrated. Harry P. Mawson (Misc.) 3200 words.

2329. Qualifications Required of Marine Engineers. Full text of Senate bill No. 1755 (Misc.) 4100 words.

2331. The Proposed Marine Board. Editorial (Misc.) 850 words.

*2353. Naval Warfare in the Narrow Seas. Rear-Admiral Sam. Long (E–Feb 12.) 600 words.

*2370. The Future Speed of Steamships. (Inv.–Feb 13.) 950 words.

†2574. Land-locked Navigation from New York City to Charleston, S. C. John C. Trautwine, Jr. (Misc.) 2800 words.

*2652. The Engineering Branch of the U. S. Navy. Editorial (E–Feb 26.) 2200 words.

*2741. H. M. Battle-ship "Ramillies." (E–March 4.) 1800 words.

*2742. The Life-Saving and Salvage Steamer "Aid." Illustrated. (Ibid.) 1100 words.

MECHANICAL ENGINEERING.

2320. Cutting Bevel Gears with Spur Gear Cutters. Illustrated. Walter Gribben (A M–Feb 25.) 1200 words.

2321. Using a Drill Press for Cutting Keyways. Illustrated. A Mechanic (Ibid.) 400 words.

2322. A Handy Saw for Pattern Makers. John M. Richardson (Ibid.) 500 words.

2323. Blue Print Frames and Drawings. Illustrated. George Guntz (Ibid.) 900 words.

2325. Limitations of the Molding Machine. Editorial (Ibid.) 700 words.

2326. Designing for the Operator. Editorial (Ibid.) 650 words.

2328. Molding of Guns, Hydraulic Cylinders, etc. Illustrated. S. Bolland (Ibid.) 1900 words.

*2346. Meeting of the Institution of Mechanical Engineers (E–Feb 12.) 6000 words.

*2355. Conical Pistons. Illustrated. Percy S. Pilcher (Ibid.) 900 words.

2416. Hangers and the Alignment of Shafting. Illustrated. A. D. Pentz (P S–Feb.) 1400 words

2420. Manilla Rope Power Transmission. Joseph H. Hoadley (P S–Feb.) 800 words.

2425. The Power Loom. Warp Tension. Cicerone (B J C–Feb 27) 1500 words.

2443. Practical Hints for Woodworkers. C. R. Tompkins (Misc.) 1200 words.

*2457. K. Banerji's Patent Calculating Machine. Illustrated. (J E–Jan 16.) 2000 words.

2466. Jacket Cores for Molding Steam Cylinders. Illustrated. S. Bolland (A M–Feb 18.) 1500 words.

2467. Designing New Machinery. I. Henry B. Morris (Ibid.) 500 words.

2468. Rubber Pattern Work. Illustrated. John T. Usher (Ibid.) 1100 words.

2469. English and American Locomotives. W. H. Booth (Ibid.) 1600 words.

2470. Equalizing Work Within Fixtures. Illustrated. A. D. Pentz (Ibid.) 2000 words.

*2495. New and Old Tools. T. B. Purvis, Jr. (L E–March.) 1050 words.

2570. Designing New Machinery. II. Henry B. Morris (A M–March 3.) 850 words.

2571. A Mechanical Problem. A. D. Pentz (Ibid.) 1700 words.

†2577. The Effect of Centrifugal Force on the Transmitting Power of Driving Ropes. Barton H. Coffey (Misc.) 1000 words.

†2589. The Development of Spiral Weld Tube Machinery. Illustrated. Geo. Ross Green (J F I–March.) 3300 words.

2597. Wood Pulleys. Illustrated. (P S–March.) 3500 words.

2674. Attempt to Invent a New Motor. I. McKim Chase (A M–March 10.) 1100 words.

2675. Designing Mechanical Movements. Illustrated. Wm. S. Aldrich (Ibid.) 2700 words.

2676. Some Press Work. A. D. Pentz (Ibid.) 1850 words.

2677. Development of a Mechanic. "Bell Crank" (Ibid.) 1150 words.

2678. Responsibility Without Control in Machine Shops. Editorial (Ibid.) 850 words.

2679. As to Standard Gauges. Editorial (Ibid.) 800 words.

2707. Something About Pattern Making. W. P. Smith (Misc.) 1900 words.

METALLURGY.

2324. Hardening Steel. A Mechanic (A M–Feb 25.) 900 words.

*2348. Metals at High Temperatures. (E–Feb 12.) 1250 words.

*2351. Gold Quartz Reduction. A. H. Curtis (E–Feb 12.) 1450 words.

2471. Notes on the Selection of Iron Ores, Limestones, and Fuels for the Blast Furnace. Fred. W. Gordon (E N–Feb 20.) 4100 words.

*2521. Iridium. (E R L–Feb 19.) 2300 words.

2622. Kansas's Great Zinc District (Misc.) 1450 words.

2694. The English Process of Antimony Smelting. Edward Rodger (E M J–March 12.) 3500 words.

MILITARY ENGINEERING.

*2371. Military Ballooning. H. B. Jones (Inv.–Feb. 13.) 1700 words.

†2438. The Effect of Wind on the Motion of a Projectile. John W. Ruckman (Misc.) 7500 words.

†2439. The Determination of the Velocities of Projectiles by Means of Sound Phenomena. Ferdinand Gossot (Misc.) 8000 words.

†2440. Range Tables for the 12-inch Cast-Iron B. L. Mortar. James M. Ingalls (Misc.) 3000 words.

*2528. Military Ballooning. Editorial (E–Feb. 19.) 1700 words.

†2560. The Position-Finding and Position-Designating Service in Sea-Coast Defenses. James Chester (Misc.) 10,000 words.

†2561. Army Transportation. J. G. C. Lee (Misc.) 9200 words.

†2562. Infantry Fire. George B. Davis (Misc.) 7100 words.

†2563. Shrapnel Fire. A. D. Schenck (Misc.) 4200 words.

2568. Smokeless Powders. A Naval Officer (I A–March 3.) 4200 words.

2727. Range and Position-Finding. Illustrated. G. Moch (Misc.) 7800 words.

*2744. Railways in War Time. Editorial (E–March 4.) 1400 words.

*2749. French Trials of Elswick Quick-Fire Guns (Inv.–March 5.) 1800 words.

MINING.

*2286. Separation of Metals from Their Ores. X. T. Wallis Barnes (Misc.) 1150 words.

*2287. The Murchison Goldfields (Misc.) 450 words.

*2288. The Walla-Walla Silver Mine (Misc.) 1150 words.

*2289. The Wadnaminga Goldfield. (Misc.) 800 words.

*2290. Separation of Metals from Their Ores. XI. T. Wallis Barnes (Misc.) 1250 words.

2293. Mining Engineers' Meeting at Baltimore (I A–Feb 25.) 6000 words.

2294. Blast Furnace Slags. I. Their calculation by graphic methods. A. J. Rossi (Ibid.) 2400 words.

2295. The Preservation of the Hearth and Bosh Walls of the Blast Furnace. Illustrated. James Gayley (Ibid.) 5200 words.

2299. The Mesaba Range (I A–Feb 25.) 1600 words.

2334. California Gold and Early River Mining. J. E. Emerson (Misc.) 750 words.

†2336. Ozokerite. Bovertons Redwood (Misc.) 750 words.

2397. Southern Arizona Mines. Theo. F. Van Wagenen (Misc.) 1600 words.

2413. Amalgamation at the Comstock Lode. A. D. Hodges, Jr. (Misc.) 2800 words.

2422. Alaskan Mines and Mining. W. (E M J–Feb 27.) 1650 words.

2423. The Cost of Producing Copper. Edw. D. Peters, Jr. (Ibid.) 2600 words.

2424. The Grosh Brothers. A Mysterious pair. Dan de Quille (Ibid.) 4500 words.

2437. The Cost of Producing Copper. S. E. Raunheim (E M J–Feb 20.) 1750 words.

2446. Tests and Requirements of Structural Wrought Iron and Steel. W. H. Morris, Wm. Kent, Oliver Williams, G. B. Dudley, R. W. Raymond, and John J. Williams (R R–Feb 27.) 6000 words.

*2451. Annual Review of the Australian Mining World (Misc.) 1400 words.

*2529. Electricity Applied to Mining. D. Selby Bigge (E E L–Feb 19.) 1100 words.

2567. Blast Furnace Slags. II. Illustrated. A. J. Rossi (I A–March 3.) 2100 words.

2604. The Mines of Brazil. A. M. Gibson (E M J–March 5.) 1000 words.

2605. Sulphur Mining in Sicily (Ibid.) 1100 words.

†2618. Plumbago Mining in Ceylon (Misc.) 500 words.

*2651. The Miners' Decision: Restriction of Output. Editorial (E–Feb 26.) 2100 words.

2695. The Ore Deposits of Creede, Colo. Illustrated. Thos. R. MacMechen (E M J–March 12.) 2900 words.

2708. Mines and Mining Processes in Colorado. J. A. Parra (Misc.) 1300 words.

*2720. Machine Mining. Lewis Stockett (C E–March.) 9000 words.

*2721. The Longwall Method of Coal Working. A. A. Atkinson (C E–March.) 4200 words.

*2722. Relative Efficiencies of the Force and Exhaust Fans, as Suggested by the Escape of Natural Gas from Broken Mains into the Mines Below. J. T. Beard (Ibid.) 1600 words.

*2723. Mining Thin Coal Seams in Missouri and Kansas. Illustrated. Arthur Winslow and Leo. Gluck (Ibid.) 4600 words.

*2725. Stripping Anthracite Seams. Illustrated. H. W. Althouse (Ibid.) 1100 words.

PHOTOGRAPHY.

2266. Mr. Ives's Photographs in the Colors of Nature. Editorial (P T–Feb 19.) 1800 words.

2267. The Studios of New York. I. (P T–Feb 19.) 1000 words.

2268. The Chemistry of Photography. Theory of the Latent Image. W. Jerome Harrison (P T–Feb 19.) 1300 words.

2269. Absorption and the Photography of Colors. Labatut (P T–Feb 19.) 1100 words.

2308. Photography as Applied to the Investigation of Electrical Phenomena. Illustrated. C. Kammeyer (W E–Feb 27.) 5000 words.

2401. The Boston Art Museum Exhibition of "Processes" (P T–Feb 26.) 2100 words.

2402. The Chemistry of Photography. Theory of the latent image. II. W. Jerome Harrison (Ibid.) 1400 words.

2583. History of the Gelatine Process. Editorial (P T–March 4.) 800 words.

2584. Where Are We Now? H. P. Robinson (Ibid.) 1550 words.

2585. The Studios of New York. II. (Ibid.) 1400 words.

2586. The Chemistry of Photography. Physical theories of the latent image. III. W. Jerome Harrison (Ibid.) 1350 words.

2698. The Chemistry of Photography. IV. W. Jerome Harrison (P T–March 11.) 1100 words.

2709. The Alkalies Used in Development. (A P B–Feb 13.) 1150 words.

2710. A Few Thoughts on the Nature and Use of Criticism. F. C. Lambert (Ibid.) 2500 words.

2711. The Application of Art to Photography. H. P. Robinson (Ibid.) 1900 words.

2712. Rapid Hydroquinone, Para-Amidophenol and Rodinal. A. Miethe (Ibid.) 2300 words.

2713. Methods for Colored Positives on Paper. Abe Lizzard (Ibid.) 750 words.

RAILROADING.

*2260. "One Hundred Miles an Hour." Charles R. Deacon (Misc.) 3300 words.

2261. Notes on Electric Street Railway Contruction. II. Car Cleaning and Car Inspecting. Illustrated. A. K. McCay (E E N Y–Feb 24.) 1100 words.

2298. How Many Railways Enter Chicago (I A–Feb 25.) 500 words.

2310. The State of Texas vs. the United States. Editorial (R A–Feb 19.) 600 words.

2311. Railways and Legislation. F. J. Kimball (Ibid.) 4900 words.

2312. Improved Methods in Railway Location. I. Reconnaissance. Illustrated. T. Graham Gribble (Ibid.) 3000 words.

2314. Roadbeds and Heavy Traffic. A Roadmaster's View. D. Sweeney (Ibid.) 1100 words.

2315. Freight Car Construction. Illustrated. D. L. Barnes (Ibid.) 3000 words.

2316. Car Roofs. J. P. Elmer and M. A. Garrett (Ibid.) 2000 words.

*2354. Communication Between Passengers, Guards, and Engine-Drivers. Illustrated. Harry Pollitt (E–Feb 12.) 850 words.

*2356. Tube-Frame Cars. M. R. Jefferds (Ibid.) 2100 words.

2360. The Reading Leases. G. (R G–Feb 26.) 900 words.

2362. Brake Tests on Lehigh Valley Railroad (Ibid.) 2900 words.

2363. Freight Car Roofs. J. C. Barber (Ibid.) 1050 words.

2365. Steel Car Construction. Illustrated. G. L. Harvey (Ibid.) 2400 words.

2367. Steel Ties and 100-lb. Rails. Editorial R G–Feb 26.) 900 words.

2391. Rapid Transit. Philadelphia's Elevated Railroad Ordinance. Editorial (Misc.) 1300 words.

2393. Railway Signals and Switches. I. Track Circuits—Battery Calculations. Illustrated. James F. Hobart (R R–Feb 20.) 2300 words.

2394. The Commercial Value of Human Life. Editorial (Ibid.) 600 words.

2395. The Basis of "Car Service" Charges. Editorial (Ibid.) 7000 words.

*2409. Speed in Locomotives.—I. The Limitations of Fast Running. M. N. Forney. II. Train-Speed a Question of Transportation. Theodore N. Ely. III. A Practical Experiment. H. Walter Webb (S M–March.) 11,000 words.

†2411. The Intercontinental Railroad Problem. Courtenay DeKalb (F–March.) 4300 words.

2426. The Latest Burlington Brake Tests (R A–Feb 12.) 4500 words.

2444. Notes on the Construction and Maintenance of Railroads in East India. Letter from Allababad. I. (R R–Feb 27.) 2600 words.

2445. Overheated Cars. A Plea for the Day Coach Passengers. "Traveling Railroader" (Ibid.) 1000 words.

2463. Parcels Express in Detroit. Illustrated. (Misc.) 1400 words.

2475. Tie Plates. Illustrated. Benj. Reece (R G–Feb 19.) 2100 words

2477. Cheap Railways for Farmers. Editorial (R A–Feb 26.) 1150 words.

2478. Farmers' Railways. Robert M. Dougal (Ibid.) 1600 words.

2479. Superintendents and Train Dispatchers. G. (Ibid.) 1000 words.

2480. Improved Methods in Railway Location. II. Tacheometry. T. Graham Gribble (Ibid.) 2600 words.

*2484. The Mt. Generoso Inclined Railway. Roman Abt (Misc.) 1000 words.

*2486. Car Building. I. Illustrated. C. B. Fairchild (Misc.) 6900 words.

*2488. Cable and Electric Motor Power on Street Railroads. "Cable Railways," Louis Bell and "Mechanical Engineer" (Misc.) 3700 words.

*2489. Track Brakes. L. Pfingst (Misc.) 800 words.

*2490. Electric Traction Abroad. Augustine W. Wright (Misc.) 1000 words.

*2500. Road Tests of Air-Brakes. Will W. Wood (L E–March.) 700 words.

*2501. Air-Brake Points. Lew. De Long (Ibid.) 700 words.

*2529. Snow and Sand Fences for Railways. W. L. Howie (E–Feb 19.) 950 words.

*2504. Car Coupler and Brake Legislation. Editorial (R A E J–March.) 3600 words.

2573. Aluminum in Railroad Work. Albert E. Hunt (Manufacturer and Builder. *m.* New York–Feb.) 3200 words.

2594. The Leasing and Consolidation of Competing Railroads. Lawrence Godkin (R G–March 4.) 1100 words.

2595. The Strength of Car Couplers of the Master Car Builders' Type. Wm. Forsyth (Ibid.) 1500 words.

2596. The Intercontinental Railroad. Editorial (Ibid.) 750 words.

2610. The Prospects of Railway Construction in 1890. Illustrated. Editorial (E N–March 5.) 2900 words.

†2634. Longitudinals vs. Cross-Ties for Railway Tracks. Illustrated. E. E. Russell Tratman (T C E–Dec.) 5200 words.

2640. Notes on the Construction and Maintenance of Railroads in East India. Letter from Allabahad. II. (R R–March 5.) 2300 words.

2641. Car Painters' Record of Passenger Equipment. Illustrated. (R R–March 5.) 950 words

2642. The Emergency Feature of Air-Brakes. Editorial (R R–March 5.) 800 words.

2644. Safety Appliance Legislation. Editorial (R R–March 5.) 2000 words.

2655. Improved Methods in Railway Location. III. Curve-Ranging. Illustrated. T. Graham Gribble (R A–March 4.) 3200 words.

2699. The Highest Recorded Train Speed. Illustrated (R G–March 11.) 800 words.

2700. The Structure of Rail Heads. Dr. Wedding (Ibid.) 900 words.

2703. Reduced Profits of the Prussian State Railroads (Ibid.) 2400 words.

2704. The Zone System and Massachusetts Railway Fares. (E N–March 12.) 2000 words.

2705. Westinghouse and Other Air Brakes on the Vanderbilt Railways (Ibid.) 1250 words.

*2714. Symposium on the Compound Locomotive (A J R A–March.) 3300 words.

2718. Fast Trains versus Slow. Wm. S. Huntington (R A–March 11.) 650 words.

2719. Improved Methods in Railway Location. IV. Report and Estimates. Illustrated. T. Graham Gribble (R A–March 11.) 3200 words.

2729. Railroad Signals and Switches. II. James F. Hobart (R R–March 12.) 3600 words.

2730. Widening and Improvement Works, London and Southwestern Railway. Illustrated. A. W. Szlumper (Ibid.) 4300 words.

SANITARY ENGINEERING.

*2405. Dust and Fresh Air. Thos. Fletcher (J S A–Feb 12.) 550 words.

*2580. Water Purification and Disposal of Sewerage. Ira H. Jewell (Misc.) 3200 words.

*2582. School Hygiene. F. D. Davis (Ibid.) 1800 words.

†2615. The Drainage and Sanitation of Baroda. Editorial (I E–Jan 30.) 1100 words.

*2648. The Economic Aspect of Sewage Purification by Electricity (E R L–Feb 26.) 1000 words.

2687. Ventilation of the House of Commons. Sir Douglas Galton (A & B–March 12.) 650 words.

2689. Sewage Disposal at Isolated Houses. Illustrated. Geo. E. Waring (A A–March 12.) 6000 words.

*2706. The Plumbers' Craft and Education. I. Prof. Garrett (N B–March.) 1300 words.

SOCIOLOGY.

2297. Indiscriminate Immigration. Editorial (I A–Feb 25.) 750 words.

*2358. Government Manufactures and Private Trade. Editorial (E–Feb 12.) 2700 words.

2368. Changes in the Text and Construction of the Inter-State Commerce Act. Editorial (R G–Feb 26.) 1600 words.

*2389. Government Treatment of Private Traders and Inventors. Editorial (I L–Feb 12.) 1350 words.

2390. Tax on Street Railways. Henry N. Whitney (Misc.) 3000 words.

2392. The Public Ownership of Public Works. James L. Cowles (R R–Feb 20.) 2400 words.

2396. Progress in Restraint. The American belief in the right of choice. Editorial (Ibid.) 900 words.

2421. Should We have a Government Testing Laboratory? Editorial (E M J–Feb 27.) 650 words.

2428. Municipal Ownership of Gas Works. Ira L. Otis (P A–Feb 15.) 2100 words

2431. Municipal Government in Large Cities. I. (E N–Feb 27.) 3500 words.

2433. The Regulation of Private Water Rates (Ibid.) 2000 words.

2460. Licensing Engineers. Editorial (B J C–Feb 20.) 850 words.

2472. The Ownership of Employees' Inventions (E N–Feb 20) 1500 words.

*2482. The Rights of Private Ownership in Railways. J. M. Batchelor (Misc.) 1000 words.

*2487. Legislative Breaches of Contract. Editorial (Misc.) 1000 words.

*2491. Concerning the Infringement of Corporate Rights. J. B. (Misc.) 1350 words.

*2505. Continental Industry and Earnings. Editorial (I L–Feb 19.) 1750 words.

*2514. The Royal Ordnance Factories and the Manufacturers (Inv.–Feb 20.) 1900 words.

*2525. Government Manufactures and Private Trade. Editorial (F–Feb 19.) 2400 words.

*2527. Private Bill Legislation. Editorial (E–Feb 19.) 1700 words.

2543. Municipal Franchises for Quasi-Public Corporations. Allen R. Foote (E W–March 5.) 2400 words.

*2559. The Farmer and Railway Legislation. Henry C. Adams (Misc.) 3600 words.

2569. Legislation Affecting the Marine Boiler. Editorial (I A–March 3.) 900 words.

2603. Should We Have a Government Testing Laboratory? B. E. Fernow (E M J–March 5.) 950 words.

2611. Municipal Government in Large Cities. II. (E N–March 5.) 3300 words.

2614. The Political Power of the Shylocks. Editorial (Misc.) 750 words.

†2616. Rules and Regulations. "Code" (I E–Jan 30.) 2100 words.

†2617. Technical Education in Bengal. "Philomath" (Ibid.) 800 words.

2619. The Proposed International Conference about the Remonetization of Silver. Editorial (Financial and Mining Record *w.* New York–March 5.) 1000 words.

†2635. Free Railway Construction vs. Government Controlled and Owned Railways. E. Bates Dorsey (T C E–Dec.) 2800 words.

2643. The Springfield Inter-State Commerce Case. Editorial (R R–March 5.) 950 words.

*2653. County Councils and Technical Education. Editorial (E–Feb 26.) 1450 words.

*2654. Water and Tramways in Parliament. Editorial (Ibid.) 1900 words.

2693. Government Tests of Timber. R. W. Raymond (E M J–March 12.) 650 words.

*2715. Combinations. Editorial (A J R A–March.) 1000 words.

2717. The Texas Raid on Railways. Editorial (R A–March 11.) 1800 words.

*2724. The Pooling of the Anthracite Coal Interests. Editorial (C E–March.) 1200 words.

2731. A Public Estimate of the Operation of the Inter-State Commerce Law. Editorial (R R–March 12.) 1250 words.

*2739. Methods of Industrial Remuneration. Book review (E–March 4.) 3000 words.

*2743. The New German Patent Law. Editorial (Ibid.) 2750 words.

*2751. The Work and Wages of Coal Miners. Editorial (I L–March 4.) 1500 words.

*2752. The Prolongation of Patents. Editorial (Ibid.) 1500 words.

STEAM ENGINEERING.

2265. The Utilization of Exhaust Steam for Heating Purposes. C. M. Morse (E R N Y–Feb 20.) 1200 words.

2359. Smoke Prevention. James Howard (R G–Feb 26.) 900 words.

2361. The Liquid Fuel Burning Locomotive on the Great Eastern of England. Illustrated. W. H. Booth (Ibid.) 3100 words.

2364. Smoke Prevention. William Metcalf (Ibid.) 2300 woods.

2417. The Economy of Multiple Cylinders. R. H. Thurston (P S–Feb.) 1600 words.

2459. The Strength of a Boiler. Thomas Hawley (B J C–Feb 20.) 1800 words.

2476. The Warren Springer Boiler Explosion

at Chicago. Illustrated. A. F. Nagle (R G–Feb 20.) 3300 words.

*2494. A Lesson on Heating Surface. John Alexander (L E–March.) 1900 words.

*2496. Smoke. Editorial (Ibid.) 1100 words.

*2497. Boiler Explosions. The Cause and the Remedy. "Fair Play" (Ibid.) 800 words.

*2498. How Much of a Machinist Should a Locomotive Engineer Be? W. H. Wesley (Ibid.) 850 words.

*2499. How to Thaw Out an Engine. Ab. Tucker (Ibid.) 1100 words.

*2503. Locomotives for Hauling Fast Trains. Wm. Barnet Le Van (Ibid.) 1200 words.

*2504. The Relative Economy of Triple-Expansion, Compound and Simple Engines. I. W. J. Jenkins (I L–Feb 19.) 2900 words.

*2506. The Strength of Cylindrical Boilers. G. R. Bodmer (Ibid.) 1300 words.

2542. How to Fire a Boiler. R. Hammond (E W–March 5.) 1600 words.

*2555. Superheated Steam. Rayleigh (N–Feb 18.) 500 words.

2598. Centrifugal Force and Resulting Phenomena. Charles E. Emery (P S–March.) 3600 words.

2600. A Smokeless Boiler Furnace. Illustrated. John L. Peslin (Ibid.) 750 words.

2601. Boiler Scale Resolvents. Rob. Haysmith (Ibid.) 650 words.

2613. Steam-Boiler Economy. Thomas Hawley (B J C–March 5.) 3100 words.

* 2629. The Relative Economy of Triple-Expansion, Compound and Simple Engines. II. W. J. Jenkins (I L–Feb 26.) 2200 words.

2645. Leaking Flues in Locomotive Boilers. A. W. Gibbs (R M M–March) 1800 words.

*2650. Superheated Steam. J. Macfarlane Gray (E–Feb 26.) 1200 words.

2696. The Lynn Fly-Wheel Accident. C. E. Emery (B J C–March 12.) 1800 words.

2697. Combustion of Coal. How and When Smoke is Produced (Ibid.) 1200 words.

2702. Locomotive Boilers. Editorial (R G–March 11.) 800 words.

2732. Boiler Feeders. W. H. Wakeman (Misc.) 1800 words.

*2750. Evaporative Test of a Three-Flued Boiler of the Lancashire Type (I L–March 4.) 4000 words.

MISCELLANEOUS.

2263. Telegraphic Shorthand. John P. Gavit (E R N Y–Feb 20.) 1000 words.

2264. The Necessity and Present Opportunity for the Establishment of a Technological Institution with Physical Laboratory and Museum of Mechanical Arts in Chicago. Francis W. Parker (W E–Feb 13.) 4800 words.

2283. My Reminiscences of Lincoln. A. B. Chandler (E R N Y–Feb 27.) 4800 words.

2296. The Cast-Iron Pipe Trade. Editorial (I A–Feb 25.) 350 words.

2300. Dinner of the Hardware and Metal Trades. Illustrated (I A–Feb 25.) 19,000 words.

2313. Medical Jurisprudence of Railway Surgery. George B. Burnett (R A–Feb 19.) 1300 words.

2317. Meeting of the Association of Erie Railroad Surgeons (Ibid.) 3000 words.

2327. Conditions of Admission to the U. S. Naval Academy (Ibid.) 1100 words.

2333. The Transportation of Petroleum. Illustrated (Misc.) 2500 words.

†2337. Melting Snow in the Streets. Thomas Fletcher (Misc.) 350 words.

*2350. The Second Law of Thermodynamics. Illustrated. G. H. Bryan (E–Feb 12.) 600 words.

2374. Problems Regarding the Cooling of Gas. H. A. Hazen (Sc.–Feb 19.) 1100 words.

2375. The Long Rivers in Nebraska. W. M. Davis (Ibid.) 1000 words.

2376. Origin of the Frigid Period in the Northern Hemisphere. C. A. M. Taber (Ibid.) 1000 words.

*2379. Notes on Cement. I. (I L–Feb 12.) 1300 words.

*2380. The Æsthetic Side of Engineering. M. E (Ibid.) 700 words.

*2384. World's Fairs. Frederick E. Sickels (J A E S–Jan.) 4600 words.

*2403. The Woodcuts of Gothic Books. Illustrated. William Morris (J S A–Feb 12.) 9000 words.

*2404. Burning Oils for Lighthouses and Lightships. E. Price Edwards (Ibid.) 12,500 words.

*2408. American Illustrations of To-day. III. Illustrated. William A. Coffin (S M–March.) 6000 words.

†2410. Industrial Progress of the South. E. P. Alexander (F–March.) 4000 words.

*2415. Journeys in the Pamirs and Adjacent countries. F. E. Younghusband (N–Feb 11.) 3500 words.

2427. Improvements in Gas Lighting. Editorial (P A–Feb 15.) 1200 words.

†2441. The London Water Supply. Sir John Lubbock (Misc.) 4300 words.

†2462. The Road from Mashonaland. J. Theodore Bent (Misc.) 5400 words.

2481. Shock in Railway Injuries. O. D. Fitzgerald (R A–Feb 26.) 2000 words.

*2483. Engineering vs. Word Painting. Walter C. Kerr (Street Railway Journal *m.* Chicago–March.) 1350 words.

*2493. Recent Travels in Indo-China. Illustrated. Lord Lamington (J S A–Feb 19.) 11,000 words.

*2513. The Action of Heat, as Illustrated by Artillery and by Some Recent Explosives. Captain A. Noble (Inv.–Feb 20.) 17 0 words.

*2526. The Home and Foreign Iron Trades. Editorial (E–Feb 19.) 2400 words.

*2556. The Columbian World's Fair. Illustrated. M. H. De Young (Cos–March.) 5000 words.

*2557. The Problem of Aerial Navigation. Illustrated. John Brisben Walker (Ibid.) 3200 words.

*2558. The United States Fish Commission. Illustrated. Richard Rathbun (Misc.) 11,000 words.

2572. Making Metal Wheels. B. F. Spalding (A M-March 3.) 2000 words.

†2579. Some Comparisons as to the Relative Value of Solid, Liquid, and Gaseous Fuel. Illustrated. Max Livingston (Misc.) 4000 words.

2602. The Diffusion of Gases. M. C. Ihlseng (E M J-March 5.) 650 words.

2607. An Analysis of Taste. George C. Mason, Jr. (A & B-March 5.) 1700 words.

2608. Value of the Study of the Antique (Ibid.) 750 words.

2612. Brass Repousse Work (B J C-March 5.) 2500 words.

*2630. Engineering Institutions and Their Work. Editorial [I L-Feb 26.) 1500 words.

*2646. The Forthcoming Exhibition at Kimberley. Lewis Atkinson (J S A-Feb 25.) 8000 words.

*2647. Ancient and Modern Art Pottery and Porcelain of Japan. Ernest Hart (Ibid.) 15,000 words.

2660. Motion and Heat. I. Daniel S. Troy (Sc-March 4.) 4800 words.

*2680. The Education of Electrical Engineers. W. E. Ayrton (Misc.) 1500 words.

†2681. Rain—Seen and Unseen. A. Ewbank (I E-Feb 6.) 3750 words.

2682. An Impending Crisis in the Iron Trade. Editorial (Misc.) 1100 words.

2716. The Contest of Motive Power. Editorial (R A-March 11.) 800 words.

2726. Work and Its Relation to Gaseous Compression and Expansion. H. A. Hazen (Sc-March 11.) 1800 words.

2728. The Importance of Our Northern Woodlands to the Navigation of the Mississppi. S. Waterhouse (Misc.) 1600 words.

*2738. Elastic Tests of Iron and Steel. I. J. Hudson Beare (E-March 4.) 2400 words.

*2746. Metric Weights and Measures. J. Emerson Dowson (El-March 4.) 1600 words.

*2755. The Spontaneous Ignition of Coal and Its Prevention. Vivian B. Lewes (J S A-March 4.) 12,500 words.

NEW PUBLICATIONS.

ATKINSON, A. A.=A Key to Mine Ventilation. Illustrated. Scranton, Pa.: Colliery Engineering Co. [157 p., $1.]

Baker, M. N.=Manual of American Water-Works: Containing history, distribution, consumption, revenue and expenses, cost, debt and sinking-fund, etc., of the water-works of the United States and Canada, with summaries for each State and group of States, and classifications by size of towns having works. New York: Engineering News Publishing Co. [12mo, cloth, 427 p., $3.]

Bax, E. Belfort.=Outlooks from the New Standpoint. New York: Charles Scribner's Sons. 12mo, cloth, 213 p., $1.]

Beaulieu, Paul Leroy.=The Modern State in Relation to Society and the Individual. New York: Charles Scribner's Sons. [12mo, cloth, 215 p., $1.]

Clark, D. Kinnear.=Mechanical Engineer's Pocket-Book: tables, formulæ, rules, and data: a handy book of reference for daily use in engineering practice. New York: D. Van Nostrand Co. [Flexible morocco, 656 p., $3.]

Clark, F. C.=State Railroad Commissions and How They May be Made Effective. Baltimore: American Economic Association. [Paper, 123 p., 75c.]

Crosby, Oscar T., and L. Bell.=The Electric Railway in Theory and Practice. New York: W. J. Johnston Co. [8vo, cloth, 400 p., $2.50.]

Cyclopædia of the Manufactures and Products of the United States. New York: Seeger & Guernsey. [8vo, half morocco, 1300 p., $10.]

Dabney, W. D.=Basis of the Demand for Public Regulation of Industries. Philadelphia: American Academy of Political and Social Science. [Paper, 17 p., 50c.]

Devas, C. S.=Manual of Political Economy. New York: Benziger Bros. [12mo, cloth, 594 p., $1.50.]

Flynn, P. J.=Irrigation Canals and Other Irrigation Works. Including the flow of water in irrigation canals and open and closed channels generally, with tables, simplifying and facilitating the applications of the formulæ of Kutter, D'Arcy, and Bazin. Illustrated. San Francisco: P. J. Flynn. [Cloth, 283 p., $8.]

Heales, A.=The Architecture of the Churches of Denmark. London: Paul. [8vo, 7s. 6d.]

Hedges, K.=Continental Electric-Light Central Stations. With notes on the methods in actual practice for distributing electricity in towns. London: E. & F. N. Spon & Co. [8vo, cloth, 216 p., 15s.]

Hempel, Walther.=Methods of Gas Analysis. Translated from the German by L. M. Dennis. New York: Macmillan & Co. [12mo, cloth, 399 p., $1.90.]

Hervey, Maurice H.=The Trade Policy of Imperial Federation from the Economic Point of View. New York: Charles Scribner's Sons. [12mo, cloth, 192 p., $1.]

Ihlseng, M. C.=Manual of Mining: based on the course of lectures on mining delivered at the State School of Mines, Colorado. New York: J. Wiley & Sons. [8vo, cloth, 450 p., $4.]

Lewis, W. Draper.=Political Organization of a Modern Municipality. Philadelphia: Ameri-

can Academy of Political and Social Science. [Paper, 63 p., 50 cents.]

Magnet, A.=Collectivism and the Socialism of the Liberal School. A criticism and an exposition. Translated by W. Heaford. New York: Charles Scribner's Sons. [12mo, cloth, 168 p., $1.]

Mendeléeff, D.=Principles of Chemistry. Translated by G. Kamensky. Edited by A. J. Greenaway. New York: D. Van Nostrand Co. [8vo, 2 vols., 1122 p., $10.]

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